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The Institute of Vitreous Enamellers

The Welsh Engineers' and Founders' Association

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Contents

	PAGE
The Psychology of Psychologists	403
Scrap Metal Problems	404
District Presidents	404
Reservation Ages for Foundry Workers Lowered	404
Random Shots	404
Castings for Enamelling	405
Founders' Forum	407
Suppressing Scale Formation in Compressor Cooling Systems	408
The Design of Die-Castings	409
Corrosion of Metals	411
Large Castings in Green Sand Moulds	411
Factors in Price Fixing	412
Problems in Pattern-Plate Making	413
Elastic Properties of Cast Iron	414
International Control of Minerals	416
The Week's News in Brief	418
Trade Talk	418
Obituary	418
Personal	418
Applications for Trade Marks	418
Company Reports	418
War Commodity Insurance	418
New Company	418
Forthcoming Event	418
Raw Material Markets	420

The Psychology of Psychologists

The Annual Report of the National Institute of Industrial Psychology, generally speaking, closely resembles those issued by all the other scientific and technical societies, though the scope of the Institute would lead one to suppose that it would make a more incisive impression than the general run. The boundaries of its work are apparently unlimited, for page 5 *et seq.* shows clearly that its activities now enter the field of industrial (mechanical) efficiency; office reorganisation; heating, lighting and ventilating; rest pauses and refreshments; and school buildings. The major activity still remains, of course, vocational suitability. It is obvious from a study of British technical and scientific organisations that there is an unwritten rule that each one "paddles his own canoe" quite irrespective of whether more suitable craft is available. Thus the Newcomen Society has no monopoly of Papers dealing with the history of engineering. This lack of system is probably all to the good, as it ensures that any particular activity is brought before a wider audience. The National Institute of Industrial Psychology, however, possesses such a very wide scope that it appears to us that a complementary policy might usefully be adopted by the various societies having activities embraced in the subjects listed. Thus the Royal Institute of British Architects, the Institute of Heating and Ventilating Engineers, the Institute of Illuminating Engineers, the Works Managers' Association, to cite but a few, might well include in the programme of lectures, Papers on the psychological aspects of their work. The profound knowledge possessed by the professional institutes would ensure that the matter discussed was apt and applicable. The best lecture ever given on safety-first in foundries, to our mind, was one given by a foundry foreman and not by a professional safety-first officer.

It is interesting to learn from the Report that work is being done on interviewing, for we have little faith in the expediency of vocational suitability tests unless the examiner is vocationally suited. This work is designed to determine (1) the factors operating during the interview which affect judgment; (2) the amount of agreement obtained by a number of people who all separately interview the same subjects; and (3) the respects in which the "board" interviews differ in their results from those given by "individual" interviews. Dealing with these three items *seriatim*, the major factor which masks good judgment is neglect of the mental reaction to test conditions by the examinee. A second fault is the excess of importance laid upon speed in accomplishing simple mechanical tasks, because the sharpest have a mentality which quickly tires of repetitive work, whereas the slower ones will find increasing interest in obtaining speed. As to the question of agreement by a number of interviewers, we would discount the judgment of all save the one who personally knows the mental make-up of the immediate overseer and the shop conditions under which the entrant will work. The "board" interviews will, if there be an exchange of views, be governed by the opinions of the man most familiar with the shop conditions. If the tests merely relate to selections for trades, without concrete employment, then, of course, the mere textbook desiderata will make for unanimity of views. This research is probably to be published later in book form, and we look forward to the time when we shall have the pleasure of reviewing it.

We have yet to be convinced that the creation of physical apparatus for the testing of vocational suitability is a step in the right direction. We could visualise two gangs of boys, one from an old-established industrial town and the other from the heart of the country, being tested by gadgets for their suitability for the mechanical trades. The country boys would show up badly, but by the time the apprenticeship period was finished, the respective proficiency of the two gangs would be indistinguishable. It seems preferable to establish some relationship between mentality and potential trade efficiency and base selection on that, rather than the performance of some mechanical tricks usually under strained examination conditions.

Scrap Metal Problems

BY "ONLOOKER."

It is a good many weeks since the order dealing with maximum prices for brass and copper scrap was promulgated, and it cannot be said that the scheme has proved to be outstandingly successful so far. The plan adopted by the Ministry of Supply, it will be remembered, provided for upper limits in the values of certain typical grades of secondary metal, the intention apparently being that no copper scrap should be sold at a price exceeding the highest price in the list, *viz.*, £49, and that similarly the "ceiling" for brass should be £41. In copper three types were listed and in brass five, the idea being that other qualities should change hands at prices bearing a reasonable relation to the control limits. In practice, however, things have not worked out altogether according to plan. For one thing, everybody with scrap for sale has been standing out for the maximum price and in consequence the merchants have had the greatest difficulty in putting through any deals whether large or small. Rumour has it, and it seems doubtful on this occasion whether rumour is the proverbial lying jade, that the order is being "got round" in various ways, while some people go so far as to assert that the order is being openly flouted.

This is certainly not a satisfactory state of affairs, for there is no satisfaction in having an order which proves on trial to be out of step with reality and virtually unworkable in practice. The somewhat spectacular step taken by the Aluminium Control in removing maximum prices from aluminium and light alloy scraps has encouraged many people in the belief that a similar course ought to be adopted for copper and its alloys. Judging, however, by the appreciation in values in the light metals it would appear that virgin metals are not in such overwhelming supply as to make scrap of only secondary importance; there has certainly been a large increase in the price of certain types of scrap and some observers believe that the rise is not yet finished.

What would happen to the prices of copper and brass scrap if the "ceiling" were removed? Most people are agreed that there would be a sharp appreciation at any rate in the initial stages, not so much because of any difficulty in obtaining supplies of virgin metals as because certain interests would take a view and buy for a further rise at a later date. One has to remember that, with the London Metal Exchange closed, dealing in futures is a thing of the past, but there are still those who wish to hedge against future possibilities, and moreover there is still the speculator to consider.

As far as copper scrap is concerned it may be argued that a check on reckless buying is provided by the fact that this commodity is controlled not only in price but also as to the fact that a seller must secure from his customer a licence to cover the purchase. Whether this ruling is strictly observed may be open to question, but it is of course very difficult to bring home to the offender breaches of the regulations. In brass the case is different, for while a measure of control exists concerning prices no licence is required to cover a purchase so that metal may be secured for any purpose.

There are those who believe that just as the Aluminium Control has advanced its price for the metal it regulates so the values of copper, zinc and lead will go up in the long run and such people would probably be prepared to back their opinion to the extent of buying and accumulating scrap metal wherever possible. At the moment brass scrap presents the most likely lock-up investment, and it would therefore seem that more and not less control of this commodity is necessary.

District Presidents

No. 2—NEWCASTLE-UPON-TYNE

Mr. E. B. Ellis, the President of the Newcastle-upon-Tyne Branch of the Institute of British Foundrymen, received his metallurgical training at Sheffield University and at the Technical College, Birmingham. After completing his apprenticeship with Cammell Laird & Company, Limited, Sheffield, he served with the Sheffield City Battalion during the Great War.

MR. E. B. ELLIS.

On his return, in 1918, he took up an appointment as chemist to Wolseley Motors, Limited, Birmingham, which firm he left in 1926, when he was appointed senior chemist to Keighley Laboratories, Limited. After nine years with this firm, during which he gained a very wide experience in all forms of metallurgy and chemistry, he took up an appointment with Sir W. G. Armstrong Whitworth & Company (Ironfounders), Limited, Gateshead-on-Tyne, and after one year was appointed chief chemist and metallurgist.

In early 1938 the works of that company were greatly enlarged, and it became necessary to open up two new works at Jarrow, these being Jarrow Metal Industries, Limited, and Jarrow Shipbreaking Company, Limited. Mr. Ellis now holds the position of chief chemist and metallurgist to the entire group.

In spite of a very busy business career, he has found time during the past three years to serve on the Cast Iron Sub-Committee of the Institute of British Foundrymen, and has read several Papers before the Newcastle-upon-Tyne and other Branches of the Institute, as well as kindred societies on the North-East Coast.

Reservation Ages for Foundry Workers Lowered

The War-time Schedule of Reserved Occupations is, of course, under constant revision by the Ministry of Labour and National Service, and the following list relating to workers in the foundry industry includes all amendments which have been notified up to the end of November.

	Previous age of reservation.	New age of reservation.
Iron and Steel Founder and Moulder:		
Cupola man, general furnace attendant	23	18
Caster, pourer (iron and steel) ..	21	18
Floor moulder (iron and steel) ..	23	18
Dresser, fettler, chipper (iron) ..	25	21
Dresser, fettler, chipper (steel) ..	25	21
Brass and Other Non-ferrous Metal Founder and Moulder:		
Moulder, aluminium (general hand)	23	18
Moulder, non-ferrous metals other than brass and aluminium (general hand)	23	18
Crucible man (pot fireman), metal mixer, furnace man	23	18
Pourer, caster (non-ferrous) ..	23	18
Dresser, fettler, chipper (non-ferrous metals)	25	21
Scientific Worker, Research Worker:		
Metallurgist	25	21

Random Shots

Some time ago "Marksman" had to confess ignorance of the meaning of some American slang, and now he is extremely grateful to Dr. H. A. Schwartz, of the National Malleable and Steel Castings Company, of Cleveland, Ohio, for a charming letter in which he explains the passage quoted. The paragraph was about a certain "brain trust" and it made reference to the "hot-dog boys" and to the "sand-lot boys." The first, says Dr. Schwartz, is political slang and is very interesting in its derivation. Hot-dog boys, apparently, are products of the Harvard Law School and protégés of the sometime professor of that school, Mr. Frankfurter. When one recalls that in the United States a Frankfurter sausage is called a "hot dog," the significance of the name "hot-dog boys" to ex-students of Frankfurter at once becomes clear.

* * *

The second phrase is baseball slang. A sand-lot ball player, says "Marksman's" interpreter, is an amateur or semi-professional, usually young, who plays baseball not for money but in open places, usually sandy. Evidently anyone who is not good at his job through lack of experience is a sand-lot boy. In England he would probably be referred to as a rabbit, which most Americans will recognise as a cricket reference, the game by which most standards of decent British behaviour are set.

* * *

Finally, Dr. Schwartz points out that it is extremely interesting to find out what Americanisms are not understood over here, and he assures the Englishman that there are many instances occuring in the opposite direction. Quite apart from the slang of the two countries it is interesting to reflect on how many straightforward words have changed in meaning or strength in their transit from England to America. There is, for instance, the word "homely," which in America is an adjective far from flattering, whilst here it conjures up pictures of cheerful firesides with comfortable slippers and a pipe. There is, too, that classic epithet which in America one applies to one's best pal with cheerful endearment even at the family dining table, whereas here, a sense of decency on the part of the writer and the Editor will not permit even of its mention. One is only allowed to say that it begins with B.

* * *

A cheerful little story comes from Mr. H. H. Shepherd, President of the East Anglian Section of the Institute of British Foundrymen, which is reproduced chiefly because it is a treat to hear a story which is not about the war.

Teacher: "What are the chief minerals of England?"

Boy: "Lemonade and ginger beer, Sir."

* * *

A little girl at the same school, by the way, wrote in an essay: "I sleep in a little ironical bedstead, which is painted white and is cold when I get hold of it."

* * *

Some firms in the enamelling industry have put on the market an enamelled identity bracelet, and one philanthropist offered to provide one to the members of a class in a girls' school. The teacher was asked to send in a list of their names and registration numbers. This was duly done and amongst the list was one which read: "This *was* Martha Moore."

* * *

Practical Politics!

Little boy to his mother: "I'm going to believe in Father Christmas just one more year because I want a bicycle and I know Dad wouldn't buy it me in wartime."

"MARKSMAN."

Castings for Enamelling*

By J. A. DONALDSON (Carron Company, Falkirk)

One has frequently heard the opinion expressed that cast iron as an essential commodity in world progress is quickly becoming less necessary; the extremists in this school of thought say that it is already doomed. These opinions are based on the fact that substitutes are, from time to time, being introduced which are claimed by their sponsors to be better and/or cheaper than when fashioned in cast iron. Examples of such substitutes which have been hailed as nails in the cast-iron coffin are steel castings, forgings, stampings and fabricated parts; spun concrete pipes, asbestos-cement rainwater goods, tiled fireplaces, and so on. To the casual observer such an array would seem to indicate that the outlook for cast iron was anything but bright, and indeed this would be the case if the iron-founder did not adopt measures to meet the situation. This he has done and is doing in three main directions, namely, by manufacturing castings by improved methods (*e.g.*, machine moulding and centrifugal casting); by employing iron with vastly improved physical properties (*e.g.*, high-duty and alloy irons), and by developing new outlets for iron castings.

Vitreous-enamelled cast iron is one of the outstanding examples embraced in the third category, and its importance as an outlet for iron castings is given in justification of the presentation of this Paper to a meeting of iron-founders.

Before proceeding to a discussion on castings for enamelling it might be appropriate to define the term "vitreous enamel," state its main properties and briefly outline the process.

Vitreous or porcelain enamel (the terms are synonymous) is made up of a carefully balanced mixture of mineral ingredients fused together at a high temperature to form a complex glass. When applied to cast iron it provides a finish having a large number of desirable properties. These include an infinite range of fadeless colours and shades, durability, ease of cleaning, high gloss, acid and alkali resistance, freedom from scratching and rusting, and heat-resistance.

The fundamental steps in processing cast iron call for annealing of the castings at a temperature of about 800 deg. C., shot-blasting the surfaces to be enamelled at pressures up to 80 lbs. per sq. in., and, in the wet process, spraying the castings with the enamels which have been previously milled to a fine consistency along with clay, colouring oxides and water. The water is driven off by drying in a hot chamber and the enamel is then fused on to the metal at temperatures ranging from 740 to 820 deg. C. In the dry process the finely milled enamel is dusted on to the hot casting and the enamel is fused out at temperatures in the region of 900 deg. C.

It will be realised from the preceding particulars that castings, during the process of enamelling, are subjected to unusually severe treatment which calls for special attention to their design. It is proposed to deal with some points on this subject, but before doing so it should be mentioned that the remarks apply to castings intended for wet processing, although many of the points apply equally to dry-process castings.

Fundamentals of Design

It should be the constant aim of the designer to provide castings free from sections uneven in thickness (such as heavy ribs, bosses, door catches, hinges, etc.) since in extreme cases blistering of the enamel will occur at these parts, while in less extreme cases the castings will require to be "double run" to fuse out the enamel equally. ("Double running" consists in heating the castings during the fusing operation until the enamel on the lighter parts has almost fused out, withdrawing the castings from the muffle partially to cool off, and returning the load to the muffle to fuse out the enamel on the heavier sections. Just as the thinner part of the casting reaches the fusing temperature sooner than the thicker part, so will the former cool more quickly when withdrawn. When the casting is returned to the muffle a second time the heavy section will be at a higher temperature and, provided the fuser's judgment is not at fault, the whole casting will arrive at the fusing temperature of the enamel simultaneously.) Such a procedure is costly since about 50 per cent. more time is required to fuse the article. A further objection to castings of unequal thickness is that, due to the inherent casting strains, they are liable to spring during the annealing, blasting or fusing stages.

DIAGRAM NO. 1A

DIAGRAM NO. 1B

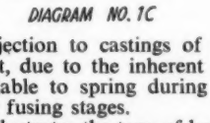


DIAGRAM NO. 1C

Fig. 1A illustrates the type of boss which causes blistering due to open structure of the iron. Should the boss be intended to take a screw shank the defect can be largely eliminated by casting it in, as it will then act as a densener. Even so, unless the boss is very light, double running will still have to be employed. Methods designed to overcome the difficulty are shown in Figs. 1B and 1C. Either method will make it possible to avoid a double run.

Design of Ribs

Heavy ribs on the underside of a casting, as well as tending to cause blistering, will frequently bring about the condition of "hairlining" of the enamel. Hairlining is due to unequal heating of the casting, which has the effect of causing the unfused biscuit of enamel to crack over the heavy area. When the enamel fuses, depressions form at the cracks, which give the enamel surface a corrugated appearance. The remedy here is to reduce the weight of the ribs or, if they are present merely to strengthen the casting, to have two or more smaller ribs in piace of the single large one (see Figs. 2A and 2B). Door catches and hinges should be cored out to give these parts the same thickness as the rest of the casting.

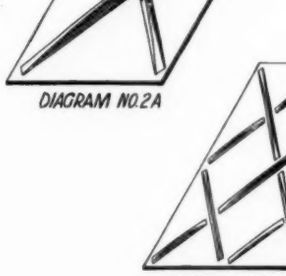


DIAGRAM NO. 2A

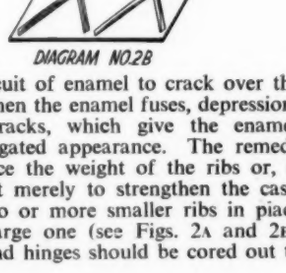


DIAGRAM NO. 2B

Deformation of Flat Castings

It is a well-known fact that the blasting of a flat casting inclines to make the blasted face convex, due to the peening effect of the abrasive. Where this occurs the cure lies in thickening the casting, or, where this cannot be done, to make the casting slightly concave on the face to be enamelled (Fig. 3). It might be mentioned here that the general tendency to reduce the weight of light castings to the absolute minimum has led to extra cost in enamelling, due to excessive warping and breakage, greatly in excess of the saving in metal.

Before dealing further with design it is necessary to explain a point in connection with wet-process enamelling practice. In this process two methods of application are used. In one the true enamel is applied over a matt ground-coat and in the other the enamel is applied direct to the blasted casting. The matt ground-coat is sprayed on to the blasted casting, dried, and fired on at a temperature of about 820 deg. C. The true enamel is then sprayed on the cold ground-coated casting and, when dried, fired on at about 720 to 740 deg. C. In the direct method the enamel is sprayed, dried and fired around 740 to 760 deg. C. Because of the fact that the enamel applied direct to the metal has a far better adhesion than the best matt ground-coat enamel, the former is always applied if the casting design and, to a lesser degree, the colour required make this possible. Should a casting be of such a design that it warps appreciably in blasting, it will require to be ground-coated in order to allow of its being fired at the matt ground-coat heat (820 deg. C.) and thus attain a temperature at which it can be straightened with the least chance of breaking.

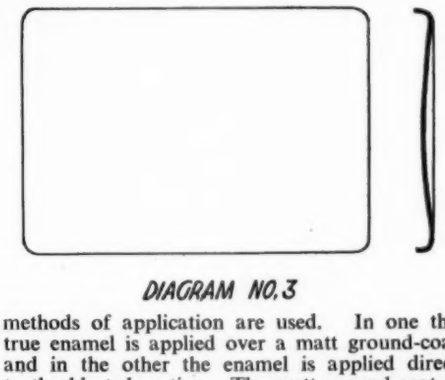


DIAGRAM NO. 3

Edges and Fillets

Another feature in design which determines whether a direct enamel can be applied is the state of edges and fillets. Should they be sharp the direct enamel will flow away from these edges, when fused, leaving a line of almost bare metal (Fig. 4A). This is not so apparent when a matt ground-coat is applied, since this coat is only partially fused, when properly fired, and so cannot flow away from the edges to the same extent. Further, the fired matt ground-coat has a surface similar to fine sandpaper, and this has the effect of holding the true enamel in place when it is fused on (Fig. 4B). It should not be assumed from what has just been said that sharp edges are permissible on castings to be

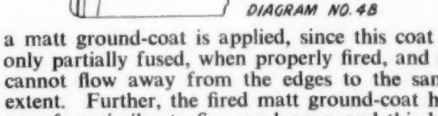


DIAGRAM NO. 4A

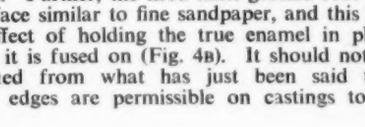


DIAGRAM NO. 4B

* Paper read before the Scottish Branch of the Institute of British Foundrymen, Mr. Norman E. Eskine presiding.

ground-coat enamelled, since the edges of an enamelled casting are more liable to chip with rough handling, and the sharper the edges the less will be their resistance to chipping. Whether castings are intended for direct or ground-coat enamelling, the edges and fillets should have minimum radii of $\frac{1}{4}$ in.

Every endeavour should be made to see that castings with projections on the underside will have these of the same depth. Castings which are not designed with this in mind will require special packing on the firing supports to avoid distortion during annealing and fusing, leading to considerable loss of muffle output. Figs. 5A and 5B typify good and bad design in this respect.

METAL COMPOSITION

It has been claimed that cast-iron pieces ranging in fracture from white to coarse grey have been successfully enamelled. There is no reason for doubting that this has been done in isolated cases, but even those who demonstrated that

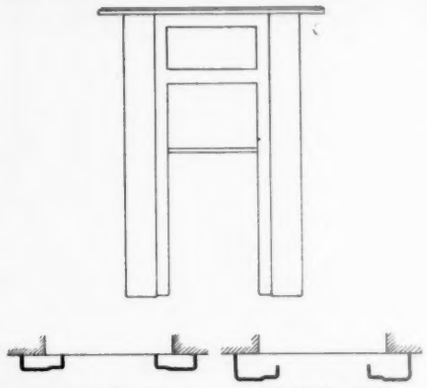


DIAGRAM NO. 5A DIAGRAM NO. 5B

this is possible would admit that to attempt to enamel such castings on a production basis would be nothing short of madness. The fact is that the fracture—and therefore the metal composition, since this almost wholly governs fracture—is of paramount importance in cast-iron enamelling. Indeed, it can be said that the regularity of composition of castings being processed in a given enamelling works has a very definite bearing on the results achieved.

Castings best suited for enamelling requirements should have a close-grained grey fracture, high density and good mechanical strength. Close control of these factors can only be obtained if the chemical composition is given full attention.

Silicon

The silicon content is the chief factor in controlling grain size and in determining the relative proportions of combined and graphitic carbon in the casting. Castings having a suitable grain size will contain from 0.40 to 0.60 per cent. combined carbon as cast.

Manganese and Sulphur

Manganese aids in densening the structure and has a stabilising action on the combined carbon, and since the main purpose of annealing castings is to break down the carbides it should not be present in large quantity. On the other hand, sufficient ought to be present to ensure that all the sulphur is combined with it to form manganese sulphide, as otherwise the sulphur will retard carbide dissociation. It is considered that if the manganese present is in excess of 1.7 times the sulphur content plus 0.3 per cent., all the sulphur will exist as manganese sulphide, in which form it has no apparent influence on enamelling results in rational quantities. Due regard should be given to the fact, however, that manganese sulphide is present in molten cast iron in minute globules, and since it is considerably lighter than iron it is reasonable to assume that, under certain conditions (for example, castings of heavy section, poured hot) the globules will segregate at the upper surfaces of the mould. Such surfaces when blasted will be pitted at the points where the brittle manganese sulphide has been removed. The obvious remedy is to keep the sulphur down to as low a percentage as possible.

Phosphorus

Phosphorus should be limited to that quantity necessary to impart sufficient fluidity for casting. Any amount in excess of this will merely increase the breakage loss, not only in the enamelling shop, but also in the dressing and fitting shops and in transit.

Having given due regard to the amount of the other constituents mentioned, the variations in the graphitic carbon of iron from a normally operated cupola will have no influence on the enamelling results.

Many compositions have been quoted as being best suited for enamelling castings, and it is not intended to add another to the list. The aim should be to arrive at a composition which gives the best all-round results and then maintain such an analysis as closely as possible. One point calling for mention in connection with these ideal analyses is that the silicon content is generally

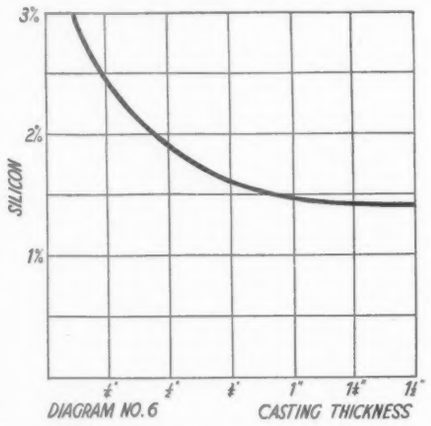


DIAGRAM NO. 6

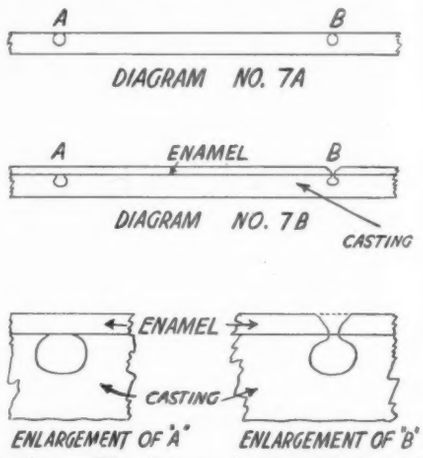
given as around 2.5 per cent. Since castings ranging in thicknesses of from $\frac{1}{4}$ in. to well over 1 in. are being enamelled and, as already stated, silicon is the main determining factor in grain size, the silicon content should be controlled accordingly. Fig. 6 gives the silicon: thickness ratio, which should provide the best structure for the mean thickness of a given enamelling casting if the other constituents are within normal limits.

Foundry Practice

Some adjustments in orthodox foundry procedure are called for in order to obtain high-quality enamel finishes. Castings should be sound internally and free from sand and slag inclusions. Special care should also be taken to ensure that the castings are perfectly smooth on the surface. The Scottish moulder has long been famed for the pleasing smooth blue finish he produces on light castings. This surface is entirely suitable for enamelling purposes provided the casting is sound below the skin, but the methods adopted to procure this finish are apt to lead to the presence of small gas-holes, which may be broken into when the casting is shot-blasted. Fig. 7A illustrates a section showing this defect. Where the gas-hole is well exposed, as at A, the void can be filled with a special clay, but where the wall of the hole is just punctured (B) it is not readily seen by the clayer. This results in a dent in the enamel surface due to some of the fused enamel finding its way into the hole beneath (see Fig. 7B). The remedy here lies in being sparing with the coal-dust and blacking. The best enamelling results will be obtained from a casting which comes away from the mould with a film of facing sand adhering. Owing to the demand for finishes in pastel shades, it is essential that the casting be sound and have a perfect surface. The well-known mottle finish effectively masks small defects on the enamelled surface which would be very obvious if the casting was pastel-enamelled.

Running and Gating

Gates should be located on the edge of the casting, and should the casting be of unequal section the gate should be set at the thinner part since this arrangement will lessen the tendency for the casting to warp. Runners should be broad and their thickness tapered to as thin a section as possible at points where they meet the casting, so that any dirt from the gate may be trapped. Flat and "pop" gates should not be used, if at all possible, because of the lined surface which generally results from this



practice. The face to be enamelled should always be cast down, and in cases where the casting is to be enamelled on both sides the less conspicuous face, when fitted, should be cast up.

It is a good practice to melt the metal hot so that any slag, etc., may have time to come to the top of the ladle before pouring commences. Botted iron should not be used, since such metal is likely to be hypereutectic, and some of the excess carbon may be precipitated on the casting face, leaving a poor enamelling surface when shot-blasted. The castings should be removed from the moulds hot and stowed well away from wet sand. Should this not be done, and rusting of the casting occurs, trouble in the enamelling process is very likely to arise.

Mention was made at the beginning of this Paper that vitreous enamelling afforded an important outlet for iron castings. It is to be expected that production will diminish somewhat during the war, but there is no doubt that the demand will revive and steadily increase when conditions return to normal. The extent of the increase will depend on the cost of the article, and if these notes have, even in the smallest degree, contributed to that end, the time given to preparing them will be considered well spent. The ironfounder will have some justification for wondering where a reduction in cost of the enamelled article comes in in view of the obviously increased cost of producing castings along the lines suggested here. He can rest assured, however, that the added cost of production in the moulding shop will be saved many times over in the enamelling shop, and that it will also result in increased durability and attractiveness of the enamel finish. Increase in demand is then sure to follow.

The writer wishes to express his thanks to Mr. George Pate, O.B.E., J.P., manager for Carron Company, for permission to present this Paper and for facilities afforded him in its preparation.

DISCUSSION

MR. D. SHARPE, in opening the discussion, said that he had no intention of offering any detailed criticism of the Paper; the subject was so specialised that only an expert could deal with it. He would, however, like Mr. Donaldson to develop the theory of the formation of the hole under the enamel. He himself was more inclined to think it was caused by a blow-out of the hole rather than a suction taking the enamel into the hole. He thought further information might help in accounting for any pinpoints found on enamelled surfaces. He agreed that design was a matter of importance and that the enameller was frequently asked to enamel castings of a wrong design; in fact, the enameller was often asked to do more than was reasonable in maintaining the shape of the complicated and ill-designed articles.

MR. DONALDSON agreed there might be an evolution of gas from the surface holes as the enamel reached the fusion point. He had shown on the screen the type of defect referred to and a section cut through the hole. The type of hole giving most trouble was that just below the surface, and it was difficult to realise that the enamel could go through so small an aperture. It was probable that the oxide on the surface of the metal became assimilated in the enamel and caused an evolution of gas.

Commenting on the graphitic carbon in the iron, which, a member suggested, was largely the cause of defects in the enamel surface, Mr. Donaldson pointed out that this question has long been a subject of discussion. Some authorities maintained that if the graphite could be eliminated no troubles would arise; others said that graphite had no effect on the enamel. He himself thought that graphite as such had no effect, but voids around the graphitic flakes had.

A Specialised Production

MR. T. TYRIE suggested that the real difficulties arose with foundries which did not regularly make castings for enamelling. Those foundries making engineering castings did not get a sufficiently clean surface to permit the enamel to adhere properly. The type of sand used was usually coarser, so they went to extremes in putting on a heavy coating of plumbago in an effort to obtain a smooth surface on the casting. No amount of shot-blasting would produce a sufficiently clean skin for enamelling purposes. Referring to the holes under the surface, he was inclined to think there might be pressure in the hole so that the enamel was blown up, and on cooling suction occurred.

There were a great many views on the graphitic carbon. He felt that the graphite itself was not the cause, but the void around the flake or that which might be formed by the burning of the graphite flake. Another aspect was the formation of a micro-chill largely composed of carbides, which in the enamelling decomposed with the formation of a very active form of carbon, which produced carbon monoxide and carbon dioxide gases.

MR. DONALDSON agreed that graphite as such was not the cause of the troubles, but rather gases formed by action of oxides which tended to cause the enamel to lift if the surface were such that complete adherence did not take place. It was essential that the surface be clean and free from plumbago or blacking, as this would tend to peel and separate the coating.

The CHAIRMAN (Mr. Erskine), proposing a vote of thanks to the author, said that many difficult problems faced the enameller, especially in the case of very thin light castings, and the Paper had been of considerable interest.

Founders' Forum

Making Sound Iron Chuck Castings

Q.—I am experiencing a good deal of difficulty in getting the castings shown on the enclosed blue-print sufficiently sound. They have to be machined all over.

A.—In the foundry technique applicable to the production of high-quality castings for chucks of the type indicated it is necessary to pay strict attention to the selection of metal of suitable composition together with appropriate distribution and design of the runners.

Composition

From practical experience the following composition has been found to give very satisfactory results for chucks of the sectional thickness in question; for heavier chucks the silicon content should be further reduced to 0.80 to 1.0 per cent. or an addition of 0.30 to 0.50 per cent. chromium incorporated in the composition:—T.C, 3.0 to 3.30; Si, 1.10 to 1.40; Mn, 0.70 to 1.0; S, 0.12 max.; P, 0.40 max., and Ni, 1.40 to 1.60 per cent.

Suggested Mixtures to Obtain Above Composition

The most economical method is to use 20 to 30 per cent. heavy-section mild-steel scrap together with 20 per cent. heavy machinery scrap, balance being made up with suitable pig-iron containing 1.20 to 1.50 per cent. silicon and 0.30 to 0.40 per cent. phosphorus. Part of this pig-iron may be of Scotch type and part of refined type.

The manganese content may be adjusted by the use of lump ferro-manganese or manganese briquettes added to the cupola charge. The nickel content is normally made by adding "F" nickel shot to the stream of metal at the cupola spout; alternatively, "F" nickel ingots may be used as a cupola addition.

If for any reason it is inconvenient to use a proportion of mild-steel scrap in the charge the following mixture may be used:—Refined pig-iron (1.0 to 1.5 per cent. silicon, 0.3 to 0.4 per cent. phosphorus), 40 per cent.; medium-phosphorus, medium-silicon pig-iron (Scotch type), 20 per cent.; and high-grade machinery scrap, 20 per cent.

In both cases up to 30 per cent. "remelt" (runners, risers, etc.) may be used with corresponding reduction of the other items.

Design and Distribution of Runners and Risers

Various methods can be successfully adopted for running such castings. In every case the aim should be to secure equalisation of cooling in all parts of the mould. If this is carefully attended to denseners should not be necessary. Thus the best plan is to fill the mould in such a way that the hot metal is distributed equally in all parts, the actual runners being placed on the thinnest sections. This procedure tends to superheat the mould walls in the proximity of the thin sections, thus retarding the cooling rate and making it more comparable with the adjoining heavier sections. Two methods typical of this are as follow:—

(*a*) Top runners placed on the thinner sections and widely distributed, as shown in Fig. 1. Three small runners (1 in. long by ¼ in. wide or ½ in. dia.) are placed on three of the ribs and are supplied with metal from a horseshoe or semi-circular pouring basin. Either a large riser or a small "popper" is placed on the remaining rib.

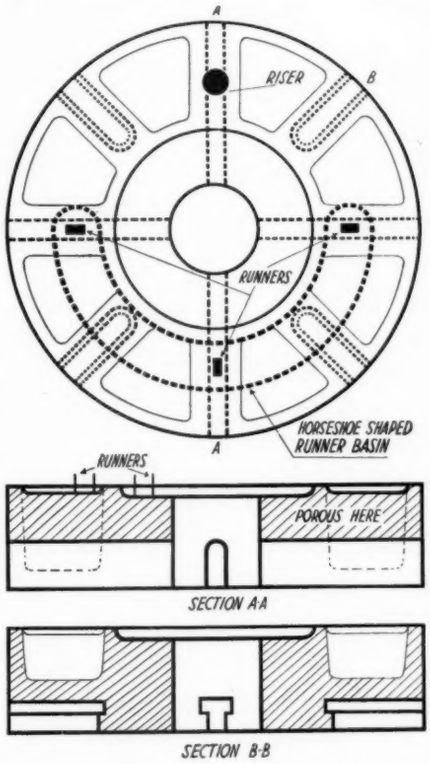


FIG. 1.—CHUCK CASTING, PLAN SHOWING RECOMMENDED METHOD, AND SECTION METHOD GIVING TROUBLE.

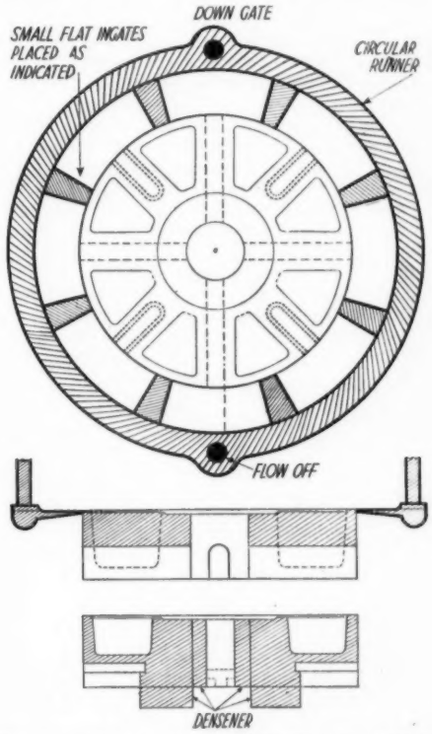


FIG. 2.—AN ALTERNATIVE METHOD OF RUNNING CHUCK CASTINGS.

(*b*) Ring-type runner completely surrounding mould with down gate at one side and flow-off directly opposite, the metal entering by small flat in-gates (Fig. 2). This second method is to be preferred as it allows the metal to enter from a number of points on the periphery and thus the centre where the heaviest mass is situated is the last to fill. Care should be taken to place the in-gates so that they are adjacent to the thin sections. By carefully-designed runners

(*Continued on page* 413.)

Suppressing Scale Formation in Compressor Cooling Systems

By F. J. MATTHEWS, B.Sc.

A simple method of water treatment that has been developed in the past year or so has proved to be very effective in preventing scale deposition in all kinds of industrial cooling systems, including compressor jackets and intercoolers and aftercoolers. The treatment, which is both cheap and simple to apply, is often called a "threshold treatment" (a term originated in America), because effective results are obtained with such small amounts of chemical that the treatment is really on the threshold of water treatment as the subject is usually understood.

Various advantages are gained in compressor operation when the cooling surfaces are maintained free from scale accumulation. Fouled intercoolers and aftercoolers result in less cooling of the air, and more moisture can be carried into the distribution lines and to consuming machines. As shown in Table I, giving the moisture-carrying capacity of air when saturated at various temperatures, even a modest increase in air discharge temperatures (from, say, 60 deg. to 80 deg. Fah.) almost doubles the amount of moisture in the air. As the temperature increases, the rate of increase in moisture content is much greater.

Moisture troubles in compressed air are well known. They include the following:—(1) Increasing frictional losses due to water pockets reducing pipe diameters; this in turn may cause such reduction of terminal pressures that machines operate much less efficiently or perhaps not at all. (2) Accumulation of moisture also involves dangers of water hammer and damage to valves and equipment. (3) Increased leakage losses are often attributable to deterioration of pipe joints as a result of a kind of electrochemical action between jointing materials and condensate. (4) Lubrication of machines may suffer due to washing of lubricant from air cylinders by the moisture, etc.

TABLE I.—*Effect of Air Temperature on Moisture Content.*

Air temperature. Deg. Fah.	Moisture per 1,000 cub. ft. saturated air. Lbs.
32	0·305
40	0·407
50	0·585
60	0·826
70	1·149
80	1·563
90	2·146
100	2·833
110	3·731
120	4·926

Local Deposits and Their Effects

Scale rarely deposits itself evenly over the surfaces affected; consequently, localised concentrations of deposition may cause increased severity of effects at some points. For instance, fouling of water jackets in the neighbourhood of valves may cause overheating and a certain amount of distortion, which in turn may be sufficient to prevent valves seating properly and so allow leakage of air back into the compressor cylinder. Repeated re-compression may thus arise in such conditions, and excessive air discharge temperatures be produced, involving increased moisture troubles and perhaps firing of oil deposits in air receivers, or even an explosion. Inefficient cooling may also cause increased deterioration and charring of the lubricating oil, with increased formation of gummy deposits which also interfere with valve operation. Increased temperatures of the air will increase the vaporisation of the more volatile portions of the oil also, and thus increase any tendency for oil accumulation in the air receiver.

In the open type of compressor cooling system the water passes once through in a continuous feed, when the scaling minerals in the water are free to deposit in compressor jackets, etc. In the closed type of circuit, the water circulates continually through jackets and is itself cooled by passage through suitable banks of auxiliary coolers in the circuit. In this case, a good quality of water may be used to circulate through the compressor jackets, and a more highly contaminated supply on the auxiliary cooler banks. While scale may be largely avoided in jackets by such an expedient, one is still faced with the problem of scale deposition on the banks of coolers, and the fact that as such scale accumulates the insulation will mean increased water temperatures in compressor jackets. Increased supplies of coolant on the banks of coolers will not be satisfactory to overcome this condition.

Scale Composition

Scale formation from cooling water supplies is invariably due to the temporary or carbonate hardness of the water. The major part of the scale is composed of calcium or magnesium carbonates, with possibly a little organic matter and silica as well. The following analysis of one such deposit is typical:—Calcium carbonate, 92.7; sulphates (as calcium sulphate), 4.2; iron oxide, 1.8; silica, 0.3; and organic matter, 1.0 per cent. The organic matter is due to organic growths or other fouling of water supplies, and the iron oxide may be attributed to chippings in removing the sample of scale. When the analysis of a raw water supply is reported, it is a convention to express temporary hardness as carbonates, though usually the minerals are present as bicarbonates. Under the influence of heat from air compression, the bicarbonates are decomposed to the carbonates which, being much less soluble, accordingly form scale. The permanent hardness (or sulphates) in a water supply does not lead to scale formation in cooling systems, since the sulphates are unaffected by the moderate heating which takes place. The low percentage of sulphates in the scale analysis above is attributable to occlusion of liquor in the scale as it deposits, etc. All that is required, therefore, is a method of preventing the deposition of carbonates.

The formation of these carbonate deposits can be prevented by the addition to the cooling water of sodium metaphosphate, the very small amount of 1 or 2 parts per million (1 or 2 lbs. per 100,000 galls.) sufficing for effective treatment. It has been found that this reagent, even in such small proportion, possesses the property of holding up carbonate deposition at cooling water temperatures until much higher mineral concentrations are reached. Recent and extensive experience of this reagent on a variety of similar cooling conditions—power-plant condensers, Diesel and gas engines, compressors, etc.—has shown that not only is fresh scale deposition prevented, but existing carbonate deposits also are gradually removed during the treatment.

The extent to which sodium metaphosphate prevents deposition is indicated by the figures in Table II, which compares the amount of deposition from treated and untreated cooling waters, a range of temperatures being given. In all cases, the waters were exposed to the temperature concerned for a full hour; the amount of treatment given was 2 parts per million of the metaphosphate. Even at very high temporary hardness concentrations, the metaphosphate is seen to exert a marked preventive effect. Where no figures are available for the amount of deposition, it is evident from the rapid increases in previous data that substantial deposition takes place with the untreated waters, while at normal compressor cooling temperatures the amount of deposition from treated water is negligible.

TABLE II.—*Percentage Carbonate Deposition from Untreated and Treated Cooling Water at Increasing Temperature.*

Bicarbonate concentration in raw cooling water. Grains per gall.	104 deg. Fah.		122 deg. Fah.		140 deg. Fah.		158 deg. Fah.		176 deg. Fah.	
	Untreated.	Treated.	Untreated.	Treated.	Untreated.	Treated.	Untreated.	Treated.	Untreated.	Treated.
14	Nil	Nil	Nil	Nil	4	Nil	8	Nil	20	Nil
28	6	Nil	18	Nil	22	Nil	30	Nil	36	1
42	23	Nil	27	Nil	32	Nil	44	3	47	8
56	50	Nil	n.d.	1	n.d.	1½	n.d.	9	n.d.	17
70	n.d.	1	n.d.	1	n.d.	6½	n.d.	n.d.	n.d.	n.d.

n.d. = Not determined.

Indirect Economies

Widespread practice confirms the above figures. A colliery operating a recirculating condensing system saved around £2,000 per annum by a treatment of the cooling water with 1½ p.p.m. of metaphosphate. In another instance, compressor jackets were maintained entirely free from scale. Indirect economies should not be overlooked. The value of improved machine operation may not be readily assessed, but the cost of mechanical descaling operations, with associated costs of idle plant, are determinable. Reduced cooling water consumption may be achieved due to improved heat transfer and in two cases this factor reduced water demands by 40 per cent. and one-third of the former consumption respectively. There is another point: due to the fact that the treatment allows a more highly mineralised supply to be carried, it may be possible to use another and more highly contaminated source of cooling water, and financial savings may result due to the greater cheapness of such supplies.

Treatment is readily applied; the reagent can be added quite simply as a gravity feed from a stock dilute solution. It is not even necessary to provide accurate proportioning gear, since the material is effective over a range of concentration. Details of treatment naturally vary to some extent according to details of cooling systems, temperatures experienced, amount of hardness in the cooling water, etc. Usually, a treatment of ½ to 2 lbs. per 100,000 galls. of water is effective. In some circumstances, it may be desirable to use a higher feed initially (not usually more than 5 p.p.m.) to accelerate removal of old scale deposits, but such increases are temporary. It is usual in recirculating systems to limit the concentration of decomposable bicarbonates (temporary hardness) by a periodical purge or blow-down of part of the water; this avoids any need for unduly high metaphosphate treatment. In systems where cooling supplies pass only once through machines, lower mineral concentrations are usually experienced, and accordingly lower treatment is effective.

The Design of Die-Castings*

The metal for die-casting should be poured into the mould at a temperature such that it may flow readily and fill the die completely, but it should not be overheated. Certain of the alloys are somewhat sluggish in flow, and may therefore have to be poured at higher temperatures than others. It is desirable that temperatures should be kept as low as possible in order to avoid large grain formation and excessive oxidation or drossing of the metal, and hence where sluggish alloys are chosen, it is advisable to avoid extremely thin sections. Cold-shuts are formed where the continuity of liquid metal in the mould is broken owing to the solidification of one or more streams of metal before the mould is completely filled.

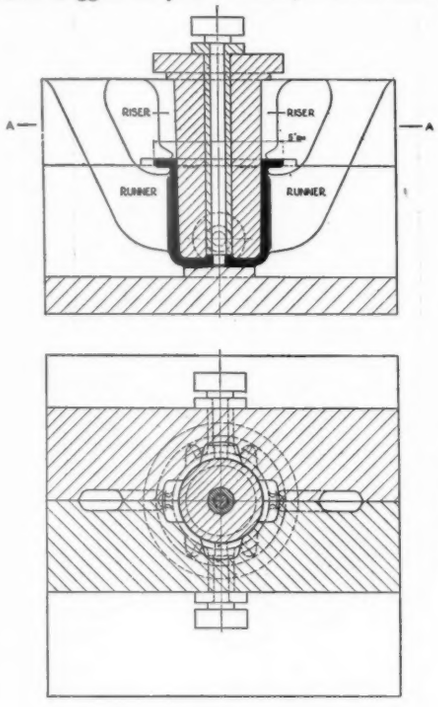
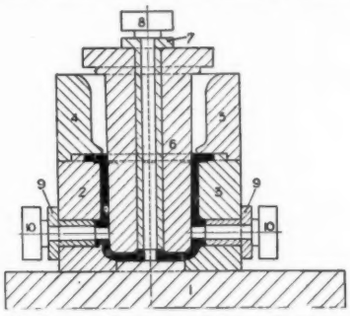


FIG. 1.—DIE-CAST HOUSING.

Aluminium alloys have a high shrinkage on solidification as compared with most non-ferrous and ferrous alloys, and this feature is more marked with some aluminium alloys than with others. Since the solidifying metal contracts, there must be a ready flow of metal if shrinkage cavities and draws are to be avoided. This is usually provided by placing risers above heavy sections so as to ensure that fresh metal from them may replace that drawn away from these sections by adjacent parts which solidify more rapidly.

Another aspect of shrinkage on solidification and contraction on cooling is that the metal tends literally to freeze on to the cores or projections round which it is situated, and this may set up stresses sufficient to crack the material in its plastic condition, or alternatively leave internal stresses in the casting which may eventually result in distortion. The effect of a high contraction value is emphasised where heavy sections adjoin thin ones, and if the change of section is very sharp, cracking is liable to occur. It is therefore desirable in the design of parts to be cast in aluminium alloys, particularly in chill moulds, to avoid having thin sections of large area between heavy sections; and in any case the change of section should be as gradual as possible. Sand cores, being less rigid, may be sometimes used to obviate cracking, but this, of course, is an additional expense. It will also be found necessary to remove the casting from the die as soon as the metal has solidified, and has acquired sufficient strength to permit of removal.

Some alloys are hot-short, *i.e.*, are weak at temperatures just below the solidification range. With these alloys particularly, precautions must be taken to avoid cracking of the casting in the mould. The worst possible combination of properties to be found in an aluminium alloy to be used in die-casting is poor running power and hot-shortness with a high shrinkage value on solidification, and such alloys present considerable difficulties in the foundry. Unfortunately, some of the strongest known casting alloys have just this combination of properties, and, where gravity die-castings of maximum strength are required, it is desirable that there should be close co-operation between designer and foundry in order to ensure the production of sound castings.



(1) Base. (2) Form block. (3) Form block. (4) Runner block. (5) Runner block. (6) Core. (7) Vent plug. (8) Core. (9) Vent plug. (10) Core.

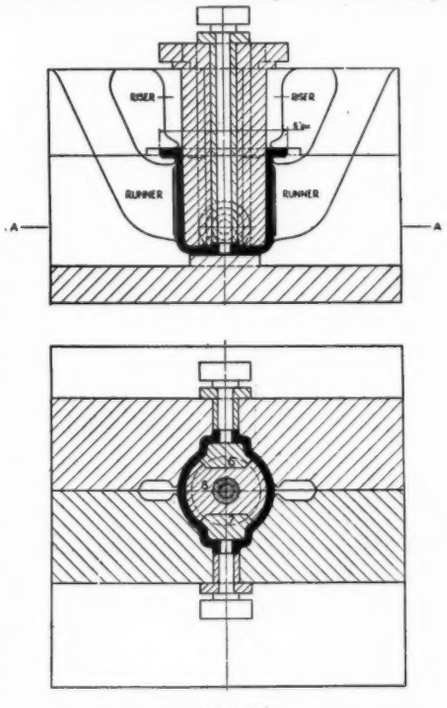


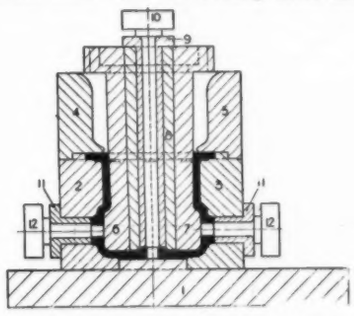
FIG. 2.—MODIFIED DIE-CAST HOUSING.

While it is not proposed to discuss in detail the technique of design of gravity die-castings, it is necessary to enlarge on the principles which must be observed in order to ensure that they may be satisfactorily produced from chill moulds with the minimum of difficulty.

The foregoing remarks with regard to running power, shrinkage on solidification and hot-shortness serve to indicate the problems with which the foundry is faced. In addition, of course, it must be remembered that the die must be such that when the metal is poured the air is easily expelled. Air-locks will result in unsound castings and make sharp definition impossible, so that venting is freely provided. Typical venting arrangements are shown in Figs. 1 and 2. To vent large surfaces fine grooves may be cut on the face of the die, and small gaps between the cores fulfil the same function.

With regard to the thinness of section which is obtainable, it is inadvisable to attempt to obtain sections of less than about $\frac{1}{32}$ in., for large castings, or $\frac{3}{32}$ in. for small ones, although thinner sections are obtainable for extremely small castings, especially with alloys whose running power is good, such as L.33 (12 per cent. silicon). Here it must be emphasised again that rapid changes of section must be avoided wherever possible.

The die should be designed so that the metal solidifies progressively towards the heavier sections, and these sections must be fed with hot metal to replace the metal drawn from them on the solidification of adjacent parts of the casting. This entails the provision of risers and gates, and the die designer's task is made more difficult if the heavy sections are in inaccessible positions. Within reason, the maximum possible draft or taper must be allowed to permit ease of extraction of the cores from the casting, and of the casting from the mould. It must be remembered, also, that the runners and risers must withdraw readily from the die.



(1) Base. (2) Form block. (3) Form block. (4) Runner block. (5) Runner block. (6) Core side piece. (7) Core side piece. (8) Core centre piece. (9) Vent bush. (10) Core. (11) Vent bush. (12) Core.

Die Design

The first essential consideration in the production of an aluminium-alloy die-casting is that it should be possible to extract it from the mould after the metal has solidified. In the simplest case, therefore, the mould is made in two halves, and the contour of the casting with its runners, risers and gates, is such that it will readily draw away from either side of the mould.

Although the die for a simple dish-shaped casting with a plain bottom and circular bosses on the underside of the rim is what is commonly known as a two-piece die, it must be noted that against each of the bosses is a vent plug which is a separate piece fixed in the die. The plug has several grooves running along its length, the object of which is to permit escape of gases from the circumference of the end of the boss. If these vent plugs were not fitted, it would be impossible to give sharp definition to the bosses and air pockets would result.

Fig. 1 shows a further development of the original shape, including radial bosses with cored

* Extracted by permission from the Sales Engineering Bulletin of the Northern Aluminium Company, Limited.

holes on the inside of the housing. It has been necessary to cast this part with the main axis vertical. If it had been attempted to make this casting on its edge, the metal would have had a very long way to flow to form the base. Moreover, while extraction of the main core would be no more difficult, it would be impossible using the same parting line to form the radial bosses. Alternatively, if the parting line were rotated through ninety degrees so that the right-hand elevation of the sketch became the plan view, the main parting line of the die would then be the vertical centre line. The die would have to be in three pieces, the third piece carrying the main core. In the method adopted, a single-piece main core is still used, and there are now three subsidiary cores. These cores are never taken right out of the die, but are drawn back before extracting the casting. The taper for the main core should not be less than half a degree, but within reason a maximum amount of taper should be allowed to facilitate extraction.

Where undercuts and exceptionally deep projections are required it may be necessary either to make the mould in several sections, or alternatively to retain the two main halves and to use loose pieces which can be manipulated to draw away from the casting. Shallow coring on which plenty of draft has been allowed may not necessitate loose cores, but as a rule the cores are not an integral part of the die. For plain holes solid cores may be used provided adequate taper is permissible, but where undercuts are desired it is necessary to use split cores. Where the coring is extremely intricate it is sometimes advisable, if not actually essential, to use sand cores.

Fig. 2 shows a further development of the housing shown in the previous illustration. The casting now has external radial bosses towards the bottom. This modification has introduced undercuts, and the main core must be made in three pieces for removal.

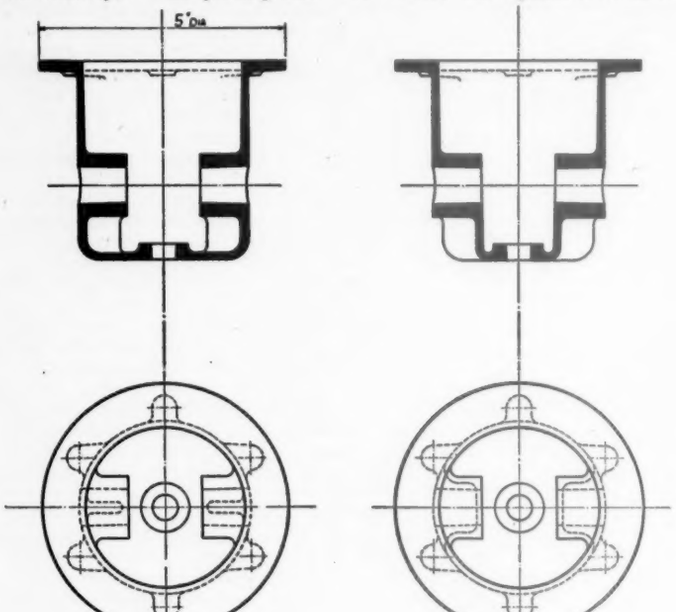


FIG. 3.—ORIGINAL DESIGN (LEFT) AND MODIFICATION OF DIE-CAST HOUSING.

Fig. 3 shows how slight modification in design, which is unlikely to affect the utility of the article, will greatly simplify production and reduce the cost of the die. In the left-hand sketch the internal radial bosses necessitate a five-part core if the cylindrical contour of the bottom of the housing is to be maintained. As shown in the right-hand sketch, by bringing the walls of the housing below the bosses flush with their inside face, a single-piece main core can be used. This modification in design is unlikely to interfere with the function of the part and provides a cheaper component.

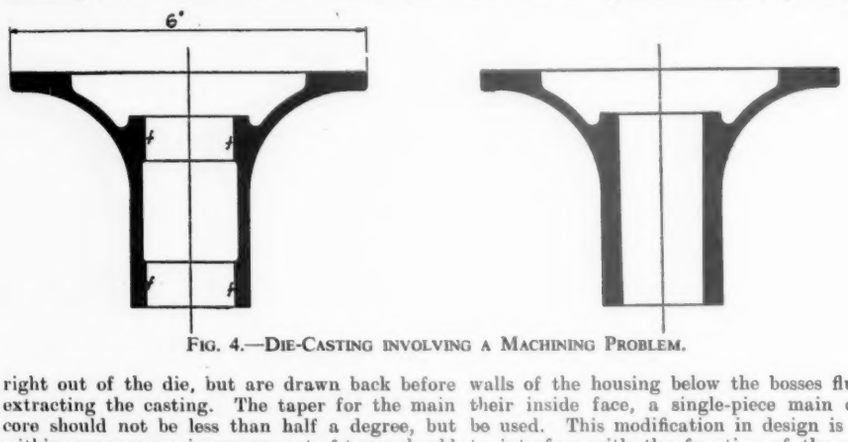


FIG. 4.—DIE-CASTING INVOLVING A MACHINING PROBLEM.

Fig. 4 shows a casting which is essentially simple, but in this case the customer asked that the undercut on the inside of the casting shown in the left-hand sketch should be cast. It will be noted that above and below this undercut machining is required. With an internal diameter of about 1½ in. it is quite impracticable to use a steel core and a sand core is necessary, although if the internal diameter were, say, 2½ in. or more, a five-piece split core could be employed. A far simpler method of production would be to machine out the undercut.

This is a case where the designer must decide whether it is more economical to buy a simple and cheap casting which must subsequently be machined, or to pay more for an intricate casting and dispense with machining. This type of problem is very frequently encountered, and designers would be well advised to ask for alternative quotations from the founder in order that they may arrive at the cheapest and best method of production.

Fig. 5 shows a pipe, such as an oil pipe, on the left hand as originally designed, and on the right hand as eventually made. The modification in design has made possible the use of two simple steel cores, but has left a sharp corner on the inside of the bend. The only way of forming a rounded corner at this point would be to use a sand core—a much more expensive method of production.

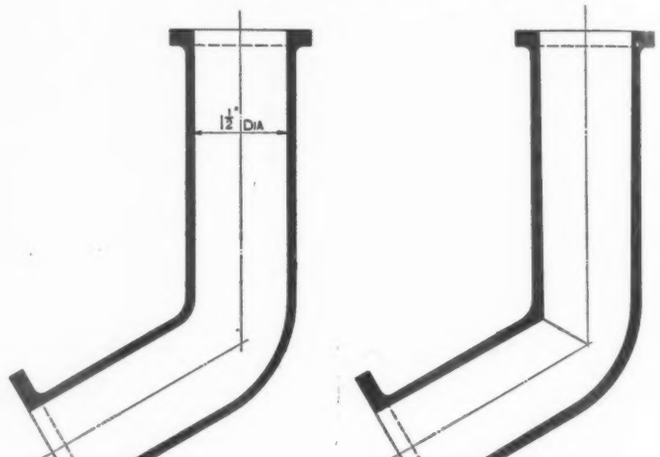


FIG. 5.—PIPE AS ORIGINALLY DESIGNED (LEFT) AND EVENTUALLY PRODUCED (RIGHT).

Fig. 6 illustrates a similar type of problem. The casting shown in the left-hand sketch could only be made with a sand core, whereas that on the right-hand side can be made with a single steel core. Since there is a progressive change in the cross-sectional area of the pipe, a sharp corner would not permit of two steel cores being used, since it would be impossible to extract the core at the narrower end.

In considering Figs. 5 and 6 it must be remembered that a steel core will give castings of better finish and appreciably better mechanical properties, so that the modification will almost certainly be well worth while.

Co-operation between Designer and Foundry

Too much emphasis cannot be laid on the fact that co-operation between designer and foundry is of the first importance, both for reasons of economy and in order to secure the best possible product. The two considerations are of course very closely related. The designer cannot afford to leave any doubt as to the soundness of the product, and must reject any defective castings. The foundryman realises this, and obviously must take precautions to ensure that sound castings are produced, and where difficulty is anticipated must adjust the price of the casting to cover eventualities. Price is to some extent a function of speed of production.

While in general it would be fair to say that the labour costs of a gravity die-casting are about two-thirds of the combined metal and overhead costs, this ratio can be considerably reduced by ensuring ease and speed of production. The advantage to be gained by co-operation with the foundry is secured in three ways. First, a simple design and choice of a suitable alloy will

very greatly reduce the cost of the die (for which the customer pays, directly or indirectly) by minimising the number of parts in the die, and possibly by dispensing with sand cores—a costly item. Secondly, the highest possible speed of production can be attained; and thirdly, the soundest possible product can be assured.

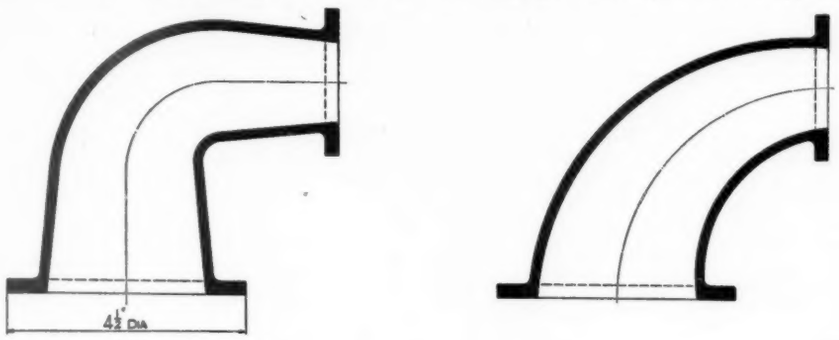


FIG. 6.—CASTING REQUIRING (LEFT) SAND CORE MODIFIED (RIGHT) TO ALLOW STEEL CORE TO BE USED.

Unfortunately, there is a strong tendency amongst founders to assume that their customers' designs will not permit of modification; and similarly, designers are not always willing to consider modifications suggested by the founders. It is fair to say that it would be extremely unwise for founders to adopt the attitude that they can produce almost any design when slight modifications here and there would materially decrease the cost of production. From the point of view of the designer, he must decide whether a simplified casting would be advisable on economic grounds, especially where subsequent machining operations may be involved. In most cases, therefore, he should simplify his design as far as possible, and may find it advisable to ask the founder to quote alternatively for a simple and a more intricate casting, so that he may ascertain whether the extra machining involved in the cheaper casting will more than offset the initial saving in cost.

Another point to be made is that the choice of alloy, especially for intricate castings, should be the subject of discussion between the designer and the founder. The designer is primarily concerned with the strength properties of the alloy, and the founder with its foundry characteristics; but the two features cannot be dissociated. It may be mentioned also that the principal aluminium founders make special provision for consultation with designers, and employ engineers whose chief function is to assist their customers in arriving at the best possible solution to the problems with which they are faced in considering aluminium alloys as engineering materials. Choice of a suitable alloy will result in the production of a satisfactory article at the lowest possible price, whilst, if the designer specifies an alloy which is either unsuitable for casting to his design, or is outside the normal range of production of the foundry, the cost will be materially increased.

Alloys

Attention so far has been concentrated on methods of production and the type of article which can be made, but little reference has been made to materials which are available. Obviously it is not within the scope of this Paper to discuss each of these materials in detail, giving notes on their foundry characteristics, uses, and so on, and these points are far better left for consultation with the founder over any projected design.

The alloy covered by Specification DTD.300 has not so far been used for die-castings. Alpax Gamma is probably the alloy most commonly used for chill castings and NA.226 is now available in this form in straightforward designs, but most of the other high-strength alloys present certain problems in the foundry.

Gravity die-castings are being used in ever-increasing quantities for parts previously made from forgings, especially in certain applications where the full tensile properties of the wrought product are not required.

Corrosion of Metals

ELECTROCHEMICAL REACTION

PROF. OLIVER P. WATTS, in the course of a Paper on "The Corrosion of Metals," published in the Bulletin of the University of Wisconsin, gives the following conclusions:—

If corrosion is electrochemical in nature, as now generally believed, it should be possible to slow down or even prevent corrosion, by suppressing either the anodic or cathodic half of the complete electrochemical reaction. Examples of restriction of corrosion at the anode are seen in the corrosion of lead by dilute sulphuric acid, of silver by hydrochloric acid, and in the passivity of iron. Partial suppression at the cathodic end of the reaction is seen in the effects of inhibitors on the corrosion of iron in dilute sulphuric acid, and of amalgamation on the rate of corrosion of commercial zinc by dilute sulphuric or hydrochloric acid.

Chromium plate owes its permanent brilliance under atmospheric exposure to a protective film formed by incipient oxidation of the metal. Aluminium is far more active chemically than iron, zinc or even chromium, and is capable of decomposing water when really in contact with it. Most of the present uses of aluminium are possible only because of the adherent and durable film of oxide which covers it. The real chemical activity of aluminium and chromium is shown when these metals are placed in concentrated hydrochloric acid, which is capable of dissolving the protective oxide films. Chromium plate is quickly dissolved and the corrosion of aluminium is not merely rapid, but violent. Silicon is another active element that owes its stability in contact with the atmosphere and moisture to a film of oxide on its surface. This ability of chromium and silicon to form protective films is used in stainless steel and duriron.

The vigorous corrosion of copper and silver by strong nitric acid, in contrast to their very slow corrosion in sulphuric acid of equivalent strength, is due to the fact that the former is both an acid and a powerful oxidising agent—a depolariser for hydrogen.

Since, in the corrosion of galvanic couples consisting of two different metals in contact in an electrolyte, the displaced metal or hydrogen is deposited on the anodic metal itself in addition to being deposited on the cathodic member of the couple, cathodic impurities in metals are entirely unnecessary to corrosion, however much their presence accelerates corrosion in certain special cases.

Large Castings in Green Sand Moulds

The East Midlands Branch of the Institute of British Foundrymen held a meeting in the institute of Ley's Malleable Castings Company, Derby, on November 18. Mr. R. H. Buckland, Branch-President, was in the chair, and the evening was devoted to a lecture by Mr. A. Whitehouse, of Sheffield, on "A General Engineering Foundry." This Paper was printed in our issues of November 3 and 10, 1938.

MR. BUCKLAND asked as to the type and position of the runners on an air-heater casting (Fig. 21 of the Paper).

MR. WHITEHOUSE said that air-heater castings were strip plate jobs. The gate was ¼ in. wide by ⅛ in. thick. When the two halves were assembled, the gate would be about ¼ in. square, and between each gate there was ½ in. of sand. The casting was run by four down gates, two on either side.

MR. J. C. HALLAMORE, referring to a cast-iron hopper (Figs. 14 to 17 of the Paper), asked how it was run, for apparently there was a small runner on the top. If so, it would be rather a long drop for the metal on to the ribs.

MR. WHITEHOUSE said the hopper casting was actually run from either side of the core, which was not face-sprigged.

MR. C. D. POLLARD, referring to the obviously very heavy core irons (Fig. 6 of the Paper), asked whether there was not a great risk of tearing or cracking trouble if speedy release of the core irons was not effected immediately pouring was completed on each mould.

MR. WHITEHOUSE said the core iron was generally eased immediately, while the casting was still red-hot. It was very rarely left overnight. It would probably be cast about 4 o'clock and by 5 o'clock the top part and the core iron would be removed.

MR. ARMITAGE inquired how long it took to get the base plate out of a casting, and what method was used.

MR. WHITEHOUSE said in that particular job it was cast at about 4 o'clock. They took out one row of bricks down the straight wall. The plate was not lifted off until next morning, and then the following morning the barrel was taken out of the core.

MR. ARMITAGE explained his method for saving the brickwork, which was to split the core into three sections. When the top plate was lifted off, the three sections could be picked out and the base plate could be released quickly.

MR. T. GOODWIN, in reference to the three-way core (Fig. 26 of the Paper), said the author had made the process sound very simple, as it had only to be taken from the core box and put into the mould. It was not so, however, as the practice in some shops was to bind it all over with cotton.

MR. WELLS asked what was the least quantity for which a special box was made.

MR. WHITEHOUSE pointed out that the exact number would depend upon the type of job. If the job was likely to be repeated, then a chance was taken, but in any case the cost of tackle was not too serious.

MR. S. E. DAWSON, in proposing a vote of thanks, said that it was refreshing to hear such a practical lecture and to see the successful results obtained by Mr. Whitehouse, which justified his conviction that the use of green-sand cores could be applied in a large number of cases where dry-sand cores would ordinarily be employed. There were, however, many cases (for examp'e, in marine-engine work) where such methods would not be suitable, and where large moulds were concerned the overall time of production might be reduced by dividing the work between the moulder and coremaker.

MR. H. BUNTING seconded the vote of thanks.

Factors in Price Fixing

By T. McALPINE

Probably in no other industry do the selling prices quoted for similar products vary to such an extent as in the foundry industry. Only recently the writer examined quotations received from six foundries for the supply of a large quantity of certain castings, and the highest price quoted was three times greater than the lowest.

Several factors undoubtedly tend to cause a variation in price. It can be expected that variations in the production facilities, ranging as they do from the completely mechanised foundry to the foundry equipped only for loose pattern moulding, will have due effect on selling prices. The number of orders in hand will also react on the price policy of a foundry. It can be expected, however, that a foundry which cannot afford to invest in up-to-date equipment will be inclined to accept only that class of work which will suit its existing equipment—for example, loose pattern moulding which is not readily adaptable to machines. This will enable such a foundry to compete on fairly level terms, with reasonable expectations of obtaining orders at prices that will yield a fair margin of profit. Indeed, it would seem that no other policy is open to this type of foundry if it hopes to remain in business.

Everything considered, it does seem that the factors which contribute most to the wide variation in quoted prices are:—(*a*) Absence of reliable cost figures; (*b*) using the wrong basis for applying the profit margin, and (*c*) deliberate price cutting—probably the result of creating a foundry which is too large for current production requirements and adopting the policy—very often fallacious—that by cutting prices and so obtaining sufficient orders to work the plant to full capacity it will swell the profits. The fact remains that the lack of uniformity in fixing prices gives the purchasers a splendid opportunity of exploiting suppliers.

Need for Reliable Costs

An efficient costing system is essential as a basis for true price fixing. Many foundries are content to work out their metal cost and productive labour cost and to leave their overhead (or oncost) charges to be allocated in one lump sum for the foundry as a whole. In other words, they make no attempt to find out what their oncost charges are for each department. Their cost figures for a certain period may appear like this:—

Example 1.

	£
Metal cost	5,000
Productive labour	10,000
Other charges (oncost)	12,700
	£27,700

With these costs as a guide they may decide that they can recover their oncost charges by allocating 127 per cent. of labour, *i.e.*, for every £1 of productive labour spent on a job £1 5s. 5d. approximately will be added to cover oncost. While this method may be regarded as a step in the right direction it is far from being satisfactory. The average foundry comprises at least four productive departments, and there is likely to be a wide variation in the cost of operating each of these departments.

The cost system should show the cost of operating each department of the foundry, which means that the oncost charges should be analysed to show the amount incurred in each department. This can be illustrated by breaking down the costs in Example 1.

For the purpose of the illustration, cupola oncost, cupola wages, laboratory charges, metal and melting materials are lumped together in one figure, and selling and distribution charges have been included in departmental oncost.

Example 2 shows the ratio of oncost to productive labour, and by the simple expedient of ascertaining the labour spent in each department on a particular job a true oncost allocation can be made.

Example 2.

	Moulding shop.	Coreshop.	Cleaning and inspection.	Cupola and laboratory.	Total.
	£	£	£	£	£
Metal cost	—	—	—	5,000	5,000
Production labour	5,000	2,250	2,750	—	10,000
Oncost	6,000	4,500	2,200	—	12,700
Total cost	£11,000	£6,750	£4,950	£5,000	£27,700
Oncost as percentage of production labour	120 per cent.	200 per cent.	80 per cent.	—	127 per cent.

One is now in a position to consider the cost of a job as based on the two sets of cost figures given in Examples 1 and 2. For illustration purposes it can be assumed that the cost figures for a certain job are:—Metal cost, £5; moulding labour, £8; coremaking labour, £4; and fettling labour, £2.

The Cost based on Example 1.

	£ s. d.
(1) Metal cost	5 0 0
(2) Productive labour	14 0 0
(3) Oncost (127 per cent. of (2))	17 15 7
Total cost	£36 15 7

The Cost based on Example 2.

	£ s. d.	£ s. d.
(1) Metal cost	—	5 0 0
(2) Moulding cost	8 0 0	
(3) Moulding oncost (120 per cent.)	9 12 0	17 12 0
(4) Coremaking labour	4 0 0	
(5) Oncost (200 per cent.)	8 0 0	12 0 0
(6) Fettling	2 0 0	
Oncost (80 per cent.)	1 12 0	3 12 0
Total		£38 4 0

To take a further example:

Cost based on Example 1.

	£ s. d.
(1) Metal cost	1 10 0
(2) Productive labour	4 0 0
(3) Oncost (127 per cent. of labour)	5 1 7
Total cost	£10 11 7

Cost based on Example 2.

	£ s. d.	£ s. d.
(1) Metal cost	—	1 10 0
(2) Moulding labour	3 0 0	
(3) Moulding oncost (120 per cent.)	3 12 0	6 12 0
(4) Coreshop labour	Nil	
(5) Coreshop oncost	Nil	
(6) Fettling labour	1 0 0	
Fettling oncost (80 per cent.)	0 16 0	1 16 0
Total cost		£9 18 0

These illustrations are sufficient to demonstrate that unless the correct method of costing is adopted, estimates may be quite misleading and the extent of the errors may make all the difference between a profit and loss. Generally speaking, the following conditions must obtain in a foundry before the allocation of oncost in one total ratio figure for the concern as a whole can be considered safe:—

(1) The ratio of oncost to labour should be approximately the same for each department, *or*

(2) the labour spent in each department should be proportionately the same for every casting.

There is certainly more work involved initially in obtaining the information necessary to allocate oncost charges departmentally, as it requires a finer subdivision of expenses; but once the primary analysis has been made, it is a simple operation to maintain the necessary records. Apart from its value for estimating, it provides the management with a greater degree of control, as it furnishes the information for controlling the expenditure of each department.

It may be mentioned that cost accounting goes far beyond the limits imposed here, but these brief remarks should suffice to show the importance of accurate costing as a basis for proper estimating.

Estimating

When the estimated cost of a job is known, the next step is to add the profit margin, and it is most important that the amount added for profit should be related to the facts of the business and not merely fixed at random. Probably the best recognised system for determining the rate of profit is:—

(*a*) Decide what would be a reasonable return on the capital invested in the business for a certain period (probably 12 months).

(2) Decide what would be a reasonable sales output for the same period and what would constitute a fair cost to be set against this output on the assumption that the foundry will operate at normal capacity and normal efficiency.

Find the ratio of return on capital (*a*) to the cost of production (*b*), and this gives the profit margin to be added to the cost of a job to determine selling price. This information can be obtained from the profit and loss accounts and balance sheets of the business. If possible, at least three years' figures should be taken to strike a normal average.

To illustrate the matter the following figures for a foundry may be assumed:—

	£
(1) Capital investment	50,000
(2) Return on capital (10 per cent.)	5,000
(3) Sales output (4,000 tons)	90,000
(4) Cost of production	80,000

Therefore, profit margin is 12½ per cent. of cost. Of course, it is not necessary to show sales value from past records because this can be calculated from (1), (2) and (4). For the same reason if (1), (2) and (3) are known, cost of production can be calculated from them without recourse to past records; but by assessing each one independently a very valuable check is obtained because it can be revealed at a glance whether the return on capital required can be attained. For example, it would be useless to fix a 15 per cent. profit on cost if the probable sales value shows that only 10 per cent. can be reasonably expected on the basis of past records.

(To be continued.)

Problems in Pattern-Plate Making*

By A. IRVINE

Among the many difficulties experienced in the making of patterns and pattern-plates are bending, twisting, springing, blistering and the like. The solution of these problems was necessarily the endeavour of foundrymen long before the real significance of metallurgy was realised. This was naturally because of the necessity of supplying straight castings. It is in the field of pattern moulding where the ability to avoid such troubles is most valuable, as a firm can thus be saved both time and money.

Steps in Production

First there is probably the master pattern itself from which an original pattern is moulded to find the bend it is going to take. Then follows the setting of the patterns for the plate. This reveals the shape of the plate and indicates whether an allowance will have to be made for any distortion in the plate, which will, of course, be shown in the resulting casting or castings. Usually it is advisable to run original patterns by the same method as will be employed when making the casting from the plate. This recommendation cannot be regarded as a hard and fast rule, but trouble often arises through alteration in gating.

While discussing the planning of a pattern-plate, there are several precautionary measures which should be noted. The first is never to have a deep pocket at one corner as it tends to cause twisting; secondly, never put a heavy casting in the corner of a plate which has one heavy casting along with a number of light ones, as this has a similar effect; thirdly, carefully control the setting of the patterns relative to the edge of the plate—by this is meant whether the resulting casting will be above or below the edge of the plate. This is a very important factor in deciding which way a plate may bend. It sometimes happens that two pattern-plates are made from the same original patterns, but one plate is set with the patterns placed one-quarter of an inch above the level of those in the other plate. The straightness of one set of castings compared with the others is worth observing.

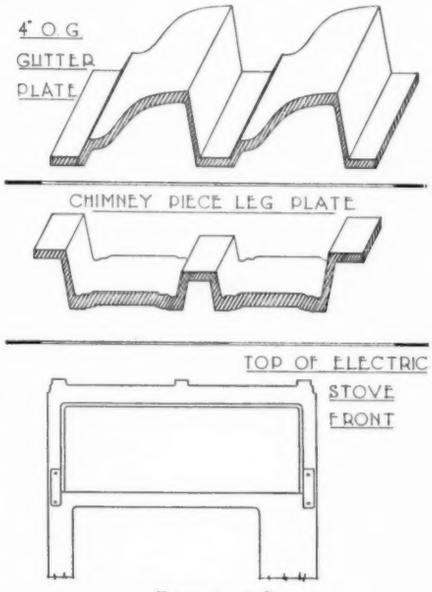
The fourth precaution to be noted is to avoid the setting of patterns for a plate which gives a dipped parting or gutter section on one edge of the plate and a flat or plain edge on the other side. The difficulty which arises is the fact that one edge takes more bend than the other. A good example of this type of plate is the O.G. gutter plate, which takes more bend on the flat side or back than on the O.G. edge. The fifth precaution is never to place a number of castings, which are comparatively narrow relative to their length, in a plate which is almost as broad as it is long, as this type of plate often takes bend on the ends as well as on the sides. The result is that the centre castings have a different sweep or bend from those on the outside edges.

The sixth point, but one which is not always avoidable, is the raising or lowering of patterns from the joint of the plate to suit plant belonging to some other job. This causes a shoulder to be formed round the plate and gives rise to a strain which generally shortens its life.

Construction or Moulding of a Pattern-Plate

The pattern or patterns should be bedded level on a hard-rammed and level top part. Some patterns may be slightly tilted to ensure better working of the plate. The facing sand should be strong enough both to bring out a pattern-plate with a fine skin and to withstand the wash of iron when being cast. If the sand be too strong, however, the thin edges, which should be sharp, may turn out faint or blunt. After the drag has been rammed firmly, it must be well vented before turning over as a pattern moulder's sand is generally very close.

When making the parting, the sand should be well formed round the edges of the patterns; to ensure that the joint between the top and bottom parts of the mould is correct, the patterns should be drawn up and placed back again. Then comes the levelling or fairing of the mould. Both sides and edges must be level and parallel before the top part is rammed. If the top side of a plate is a plain surface, weaker and more open sand should be used in order to guard against blistering. After the mould has been parted and the patterns have been withdrawn a careful examination of the runners cut to the castings should be made.



FIGS. 1 TO 3.

It is safest to have a heavy face on a runner as it can be more easily reduced than added to. Heavy parts such as screw bats and core prints should have a wrought-iron nail or wire inserted at that part of the mould to avoid drawing or sinking. Empty corners should have strengthening bars cut out of the mould to add strength and preserve uniformity. Where cores stand up prominently in the drag, they should be supported by sprigs and gently dried and finally allowed to cool before closing. It is also good policy to make up the gate heads before casting, and it should be ensured that the plate runners are large enough to allow the mould to be filled quickly and evenly.

"Stripping" the Plate

As is well known, there are not many plates which, if left to take their own course, would come from the mould perfectly straight. This, of course, mainly depends on the section of the plate, and a pattern moulder must use his own judgment if or when to "strip," as it is called, his plate. This means to turn the box in which the plate is being made, on to its side, and strip the sand from the place where the plate is likely to bend. The object is to accelerate the rate of cooling at that point and thus counteract the pull which would otherwise take place.

Although regularity in section is desirable in a plate pattern, it is not the only factor which enters into the bending or twisting. For example, a plain flat pattern-plate, which may be required for subsequently fixing wooden patterns to it, requires to be stripped or bared on the drag side to keep it straight. This may seem curious as one is apt to imagine that this is the most regular type of casting one can encounter, but the fact that the top-part side cools first is another factor which enters into the pattern moulder's consideration. It is interesting to compare two plates of different kinds and yet similar in action. A gutter plate as shown in Fig. 1 comes up at the ends or, as it has a sweep on its edge, straightens itself partly. A chimney-piece leg plate as shown in section (Fig. 2) and which is moulded the opposite way down from the gutter plate comes up in the centre.

Thus it can be seen that plates of similar section, although moulded differently, behave similarly. Even loose patterns have similarities. An example is a combination grate front or an electric stove front (Fig. 3), both of which have two openings in them. It is invariably the case that the top section curves or bends upwards as illustrated. This is simply explained by the fact that this top section is joined at the ends to the rest of the casting by members which are relatively short and which shrink on cooling, thereby exerting a pulling action on it.

In conclusion, it is essential for a pattern moulder to provide himself with good plant. Boxes should be rigid and fitted with V-pins to ensure that no mistake can arise through the box going off its twist. Also, patterns from which the plate is to be moulded should be carefully filed and well varnished.

DISCUSSION

In the short discussion which followed the reading of the Paper, MR. R. R. SHAW (former President of the Section) asked whether the author had ever tried to pot out a casting to eliminate bend.

MR. IRVINE said he had not, but it had been done in the district, although in the majority of cases they were moulded round side up. He had been advised not to use that method as it had already been tried and had failed. Mr. Irvine pointed out that a plate had to straighten itself, and a moulder received his patterns with a certain amount of bend on them.

Founders' Forum

(*Continued from page* 407.)

of this type it is possible to equalise the cooling rate so that risers may be dispensed with. However, it will be advisable to place a small "popper" on each rib near the centre core.

In both cases the mould should be arranged in such a way that an adequate height of liquid metal is provided in order to exert as much fluid pressure as possible. This is achieved by raising the level of the pouring basin to the desired height.

In exceptional cases where inequality of sections is very great, denseners may be placed on the bottom face or in the centre core or in both positions. This will tend to give extra density to the structure in the heavy section and also promote equalisation of cooling rate, and if the composition recommended above is used there need be no fear of hard spots, provided the denseners are kept approximately ¼ in. away from edges or corners.

Wherever possible, the moulds should be blacked and dried and in every case the castings should be poured with good, clean, hot metal.

* Short Paper read before the Falkirk Section of the Institute of British Foundrymen, Mr. J. A. Donaldson presiding.

Elastic Properties of Cast Iron

By ALEXANDER I. KRYNITSKY and CHARLES M. SAEGER, Jun.

(*Concluded from page* 394.)

Tucker[9] concluded that neither the breaking load, deflection, nor resilience values gave reliable indications of the resistance to thermal shock, but that the plastic resilience, expressed in percentage of the total resilience, furnished a measure of the relative toughness of the irons that he investigated. Such values of plastic resilience of the bars in the present investigation were obtained by subtracting from the total resilience the elastic resilience computed on the assumption that the elastic-deflection curve was a straight line between the origin and the breaking point. These values, expressed as percentage of the total resilience, are given in Table IV. The data show that the plastic resilience values for each iron are slightly lowered when the maximum heating temperature is 1,600 deg. or 1,700 deg. C.; the effect of varying the pouring temperature, after heating to a particular maximum temperature, is not definite.

According to the data in Table IV, the ratio of plastic to total resilience (in per cent.) of

FIG. 8.—LAMINATED STRUCTURE IN SMALL GRAPHITE PARTICLE. UNETCHED. × 2,000.

iron B is definitely higher than that of either of the other irons, with the values for iron A slightly lower than for iron C. According to Tucker's data, this indicates that the medium cylinder iron B is definitely more resistant to thermal shock than either of the other two, and that the soft iron C is somewhat better than the high-strength iron A in this respect. It is interesting to note the grouping of the three irons classified in this way and according to the total resilience. On the basis of a comparison of the percentage of plastic resilience, iron B is superior with irons A and C paired, whereas, if the comparison is based on the total resilience (Fig. 6), irons B and C are quite similar and A is different. These results indicate the complexity of resilience determinations and the difficulty of their interpretation.

EFFECT OF MAXIMUM HEATING TEMPERATURE ON COMPOSITION AND STRUCTURE

After completing the transverse tests, the bars were sampled for chemical analysis and for microscopic examination. The analytical data are summarised in Table V, which gives average values, for each iron, for all the metal that was heated to a particular maximum temperature, irrespective of the temperatures at which the bars were poured. Although data on this point are not included in Table V, variations in pouring temperature did not appreciably affect the content of any of the elements determined.

The data show that there was no appreciable variation in the silicon, manganese, phosphorus and sulphur contents with variations in maximum heating temperature. There was, however, a definite tendency for the total carbon to decrease with increasing temperature of the molten metal. The metal was melted in a magnesia crucible with the surface of the melt exposed to the air. Under these conditions, some loss of carbon by oxidation at the higher temperatures would be expected. The total carbon contents of all the bars are close to or slightly less than the eutectic values computed from the amounts of silicon and phosphorus present. The combined carbon contents of bars of iron A are close to the eutectoid composition for the low-strength bars and exceed the eutectoid composition for the high-strength bars. In all bars of irons B and C the combined carbon is less than the eutectoid amount.

In general, the strength of cast iron increases with decreasing amounts of graphitic (or total) carbon. Data for the breaking loads, in Table V, show that the bars of iron A had higher strengths and lower graphitic carbon contents than the corresponding bars of either B or C. Furthermore, in each of the three irons, an increase in maximum heating temperature decreased the amount of graphitic carbon and increased the strength. Evidently the strength and associated properties of these irons are affected by the amount of graphitic or total carbon, but examination of the microstructure shows that there are variations in the size of the graphite flakes and in their distribution, as well as in the amount of graphitic carbon.

The relations between the strengths, compositions and structures of the three irons may be summarised as follow:—

(1) The increase in strength of each of the irons after it has been heated to a high temperature is associated with a decrease in the amount of graphitic carbon and in the size of the graphite particles and with an increase in the uniformity of their distribution.

(2) The high strength of iron A, as compared to irons B and C, is associated with lower graphitic carbon and higher combined carbon contents.

UNUSUAL STRUCTURAL FEATURES IN CAST IRON

An unusual structural condition was observed in many of the graphite flakes of iron C, in which an appreciable portion of the graphite appeared to be sub-divided into roughly hexagonal grains. This condition was readily apparent in the micrograph of low-strength iron C, and was also evident, although less pronounced, in the micrograph of a high-strength iron C. Nipper[10] observed similar structures in samples of graphite laminæ, but it is not entirely clear from his Paper whether these laminæ are natural graphite or have been isolated from cast iron. The present example of hexagonal graining in graphite refers definitely to the structure of graphite in cast iron.

Several of the specimens of iron C also showed a tendency towards a dendritic structure in the arrangement of graphite particles. This tendency is evident in portions of the micrograph of the high-strength bar of iron C, but in no case was the dendritic structure developed to such an extent that the properties of the bar were definitely affected.

Several of the micrographs suggest the existence of a laminated structure in some of the graphite particles. Examination under higher magnification confirmed this suggestion by showing that laminated areas existed in some of the large graphite particles and that the structure of some of the smaller particles was almost entirely laminated. This condition was most pronounced in specimens from high-strength bars of iron A, in which the combined carbon is hypereutectoid, but was also observed in hypoeutectoid, low-strength bars of iron A and occasionally in both high- and low-strength bars of iron B. These laminated structures were observed in specimens from the unstrained ends of the bars as well as in specimens from locations adjacent to the fractures and, therefore, were not caused by stress deformation of graphite particles during transverse loading. Furthermore, the laminated appearance persisted through repeated repolishings and hence was not an accidental or surface phenomenon.

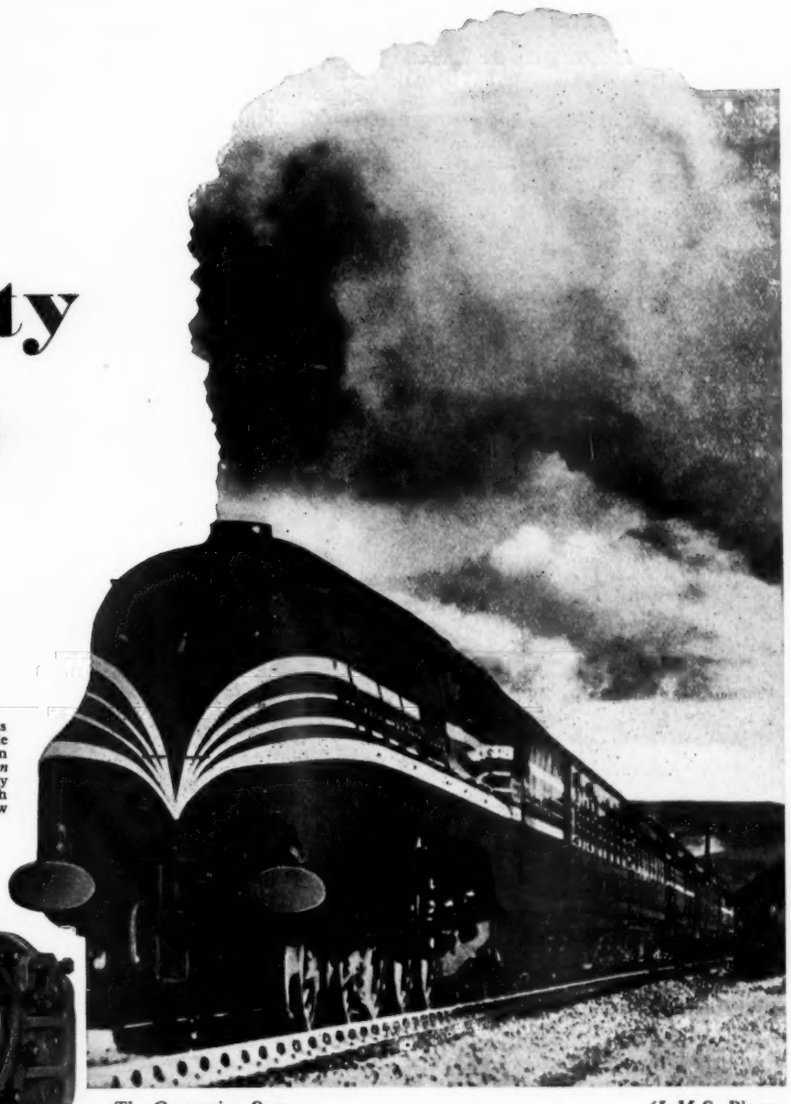
Discussion of the mechanism of formation of graphitic particles involves the controversial questions of the double iron-carbon diagram, that is, the question whether graphite in cast iron is formed at eutectic or eutectoid temperatures, or both. Arguments for and against the double diagram were reviewed by Epstein,[11] who concluded that the existence of the iron-graphite eutectic had been confirmed by observations of eutectic-like structures and that the existence of the iron-graphite eutectoid had been indicated by the results of thermal analyses, although no one had been able to illustrate satisfactorily the appearance of the iron-graphite eutectoid. In a recent Paper, Wells[12] concluded that the iron graphite eutectoid occurs at 738 deg. C. and 0.69 per cent. of carbon, and that the graphitisation observed in high-purity alloys of iron and carbon resulted directly from decomposition of austenite as well as from decomposition of cementite. Boyles' recent Paper[13] indicates that the large flakes of graphite in cast iron were formed during the solidification at eutectic temperatures and that subsequent decomposition of austenite or carbide at sub-eutectic temperatures produced finely-divided graphite which had little effect on the flake structure.

The authors' conclusion that the laminated graphite structure, shown in Fig. 8, was formed by eutectoid decomposition of austenite or carbide is in agreement with the conclusions of these other investigators. Laminated structures have been observed in some examples of eutectic alloys, but the best-known example of laminated structure is pearlite, which consists of alternate laminations of ferrite and cementite in the proportions of the eutectoid composition. The appearance and structure of the laminated graphite are similar to those of pearlite, and it is reasonable to assume that the laminated graphite also is a result of a eutectoid decomposition, one in which austenite (or carbide) decomposes to form laminated graphite and ferrite. The micrographs (one of which is shown in Fig. 8) therefore are offered as photographic evidence of the existence of the iron-graphite eutectoid.

The mechanism of simultaneous formation of pearlite and laminated graphite in adjacent areas accounts for the observation of the existence of the laminated structure in numerous small areas along the boundaries of large grains of graphite. The structure of the pearlite is not revealed in the polished but unetched specimens.

Although Bolton,[14] in a discussion of a somewhat similar structure, suggested that the black area might not be graphite, the authors believe that the black area in Fig. 8 is graphite, containing definite indications of a laminated structure closely related to the structure of pearlite. The present data do not indicate whether the laminated graphite is formed by eutectoid decomposition of austenite or of carbide. However, Wells[12] has shown that either of these reactions can produce graphite in high-purity iron-carbon alloys.

For Quality Castings



The Coronation Scot (*L.M.S. Photo*)

In locomotive castings such as that shown below, Stanton-Dale Refined Iron was used. Dale Iron was chosen for all the ten *Coronation* class engines and can be confidently used in the manufacture of all high duty castings to rigid and narrow specifications.

STANTON-DALE REFINED PIG IRON

Grade	Silicon. %	Sulphur. %	Phosphorus %	Manganese. %	Total Carbon. %
A	1·9-2·1	0·06	0·7	0·8-1·5	2·6-2·8
B	1·4-1·6	0·07	0·7	0·8-1·5	2·6-2·8
C	0·9-1·1	0·08	0·7	0·8-1·5	2·6-2·8
D	2·4-2·6	0·05	0·5	0·8-1·5	2·6-2·8
E	0·9-1·1	0·08	0·25	0·8-1·5	2·7-2·9
F	1·4-1·6	0·07	0·25	0·8-1·5	2·7-2·9
G	1·9-2·1	0·06	0·25	0·8-1·5	2·7-2·9

In addition to the above standard grades, this iron can be supplied to individual specification.

Produced under the most rigid chemical control, Stanton-Dale is a refined iron of dense, close-grained structure, with a total carbon of 2·6 to 2·9 per cent.

The use of "Dale" iron will give a tensile strength of 16-18 tons per square inch, and it is in wide demand for the production of motor car cylinder blocks, locomotive cylinders, hydraulic and pressure work—in fact for all high duty requirements.

Any analysis can be supplied to meet individual requirements.

The Stanton Ironworks Company Limited, Near Nottingham

The largest producers in Great Britain of foundry pig iron for the free market

SUMMARY

(1) A new method of measuring the deflection of test-bars under transverse loading has been developed. Measurements of deflection under interrupted loading can be continued up to the breaking point of the bar and the accuracy of these measurements is entirely independent of the rigidity of the testing machine and the mountings of the bar.

(2) The properties of three types of cast iron were determined by measurements under transverse loading. Iron A was a stove-plate pig-iron to which 10 per cent. of basic open-hearth ingot iron had been added, iron B represented the medium cylinder type of cast iron, and iron C was a soft iron of the type used for general castings. The average breaking load of iron A was appreciably greater than the breaking load of either irons B or C, and, consequently, the elastic properties of A were generally superior to those of B or C.

(3) Variations in the maximum temperature to which the liquid metal was heated affected the composition, structure, and properties of the test-bars. An increase in the maximum heating temperature decreased the amounts of total and graphitic carbon, decreased the size and increased the uniformity of distribution of the graphite particles, and in general increased the transverse strength and elastic properties. The properties of iron A were more susceptible than those of B or C to variations in the maximum heating temperature.

(4) Variations in the temperatures at which the test-bars were poured had less effect than variations in maximum heating temperature on the composition, properties, and structure. However, there was a tendency for some of the properties to decrease with increasing pouring temperature, particularly for iron A.

(5) The results of the transverse tests indicate that the initial portion of the elastic-deflection curve is a straight line, but at approximately half of the breaking load the curve inclines towards the deflection axis. For all bars of iron A the points of inflection occurred at loads between 1,400 and 1,800 lbs.; for irons B and C the limiting value lay between 1,200 and 1,400 lbs. Because of the curvature of the elastic deflection curves, a value for the relative modulus of elasticity, computed from the data for any point on the initial linear portion of the curve, is approximately 1,000,000 lbs. greater than a similar value computed from the load and deflection at the point of rupture.

(6) Two unusual structural conditions were observed, indications of the existence of hexagonal-like grains within some of the graphite particles of iron C, and evidence of the existence of a laminated structure, resembling that of pearlite, in many of the graphite particles of irons A and B, particularly the former. The laminated graphite structure is considered to be that of the iron-graphite eutectoid composition.

Grateful acknowledgment is made to Mr. L. D. Jones, Mr. C. E. Jackson, and Mr. G. W. Wells for assistance in this investigation, and to Mr. H. L. Whittemore for his counsel.

TABLE IV.—*Relation of Plastic to Total Resilience of Three Irons.*

Iron A.			Iron B.			Iron C.		
Temperature. Deg. C.		Ratio of plastic to total resilience. Per cent.	Temperature. Deg. C.		Ratio of plastic to total resilience. Per cent.	Temperature. Deg. C.		Ratio of plastic to total resilience. Per cent.
Maximum.	Pouring.		Maximum.	Pouring.		Maximum.	Pouring.	
1,400	1,400	32	1,410	1,410	46	1,400	1,400	34
1,400	1,350	28	1,410	1,360	49	1,400	1,350	*37
						1,400	1,300	*32
1,500	1,500	29	1,510	1,510	48			
1,500	1,450	29	1,510	1,460	46	1,500	1,450	*35
1,500	1,400	29	1,510	1,410	47	1,500	1,400	*35
1,500	1,350	32	1,510	1,360	45	1,500	1,350	*37
						1,500	1,300	*35
1,600	1,500	26	1,600	1,510	40			
1,600	1,450	26	1,600	1,460	46	1,600	1,450	*35
1,600	1,400	30	1,600	1,410	44	1,600	1,400	*33
1,600	1,350	35	1,600	1,360	*46	1,600	1,350	*33
						1,600	1,300	*32
1,700	1,500	27	1,700	1,510	*42			
1,700	1,450	26	1,700	1,460	*42	1,700	1,450	*28
1,700	1,400	26	1,700	1,410	43	1,700	1,400	*32
1,700	1,350	30	1,700	1,360	43	1,700	1,350	*25
						1,700	1,300	*29

* Average value of two bars. Other figures are average of four bars.

TABLE V.—*Effect of Maximum Heating Temperature on the Composition of Cast-Iron Bars.*

Iron.	Maximum heating temperature. Deg. C.	No. of bars.	Percentage average composition.							Breaking load.* Lbs.
			T.C.	C.C.	Gr.	Si.	Mn.	P.	S.	
A	1,400	8	3·46	0·90	2·56	1·24	0·14	0·46	0·024	2,210
A	1,700	16	3·20	1·04	2·16	1·22	0·15	0·46	0·025	2,567
B	1,410	8	3·82	0·74	3·08	1·25	0·48	0·172	0·059	1,780
B	1,700	16	3·66	0·72	2·94	1·29	0·55	0·170	0·061	2,010
C	1,400	12	3·54	0·58	2·96	2·36	0·72	0·39	0·056	1,780
C	1,700	16	3·39	0·64	2·75	2·38	0·75	0·40	0·058	2,210

* Corrected to bar diameter of 1·2 in.

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[11] S. Epstein, "The Alloys of Iron and Carbon," 1 (McGraw-Hill Book Co., Inc., New York, 1936).
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International Control of Minerals

POSSIBLE OUTCOME OF THE WAR

Dr. C. K. Leith, chairman of the Minerals and Metals Advisory Committee to the U.S. Assistant Secretary of War, and an authority on the world's mineral resources, stated recently in a lecture at the celebration of the 75th anniversary of the Columbia University School of Engineering, that unless there is a social or political break in the Allies front which will impair the blockade, or unless Germany can wrest the control of the seas from the Allies, the ultimate defeat of Germany by the inexorable pressure of raw-material sanctions seems inevitable. It was a question of sheer weight of metal. He thought a probable outcome of the war would be an extension of public control of mineral resources, both national and international. "The plexus of controls of one kind or another already in existence—public and private, national and international—may evolve into what amounts to international control of minerals. Whatever its merits or demerits, whether we like it or not, such control seems to be coming on. The problem now is to find out how intelligently we may direct that control in the interest of public welfare and peace," continued Dr. Leith.

"The present war seems to be resolving itself into a war of sanctions, with mineral raw materials high up in the list," he said. "Germany's most critical needs for minerals in bulk are oil, copper and iron, though there are many other deficiencies of minerals needed in smaller volume, notably nickel and tin. None of the bulk minerals can be secured in sufficient quantities from the countries to the east, including Russia."

Access to the northern Swedish iron ore was a paramount need. Usually two-thirds of this was brought into Germany from Narvik on the Norwegian coast but now it would all have to be transported through Lulea, on the Gulf of Bothnia, which is frozen during the winter. The closing of this source of supply would be a difficult problem for the Allies, and Baltic strategy would largely centre around it.

No one knew how far Germany had protected herself in the accumulation of stocks, but the best estimates so far as mineral deficiencies were concerned seemed to be about six months. This did not mean the end of the war in that time because no one knew how far substitution and the use of inferior materials may prolong the German effort, continued Dr. Leith.

Assuming an Allied victory, would any attempt be made to do something about the administration of the world's mineral resources in such a way which would minimise this cause of war? asked Dr. Leith. Inequalities of distribution of raw materials among nations played a part in starting the last war and in its outcome. They have played a part during the growing international difficulties in the interval between the last war and the present war. They loom now as primary objectives of Germany and other "have-not" nations. Their control by the Allies seems likely to determine the outcome of the present war.

Combustion of Pulverised Coal

In "Feuerungstechnik," W. GUMZ deduces a formula for calculating the combustion period for pulverised dust in suspension without the aid of empirical constants, from which the marked effect of the fineness of grinding and excess of air on the combustion rate is apparent. Is is found that other properties of the coal, such as the density, volatile matter and swelling capacity, and the temperature have less influence on the combustion rate.

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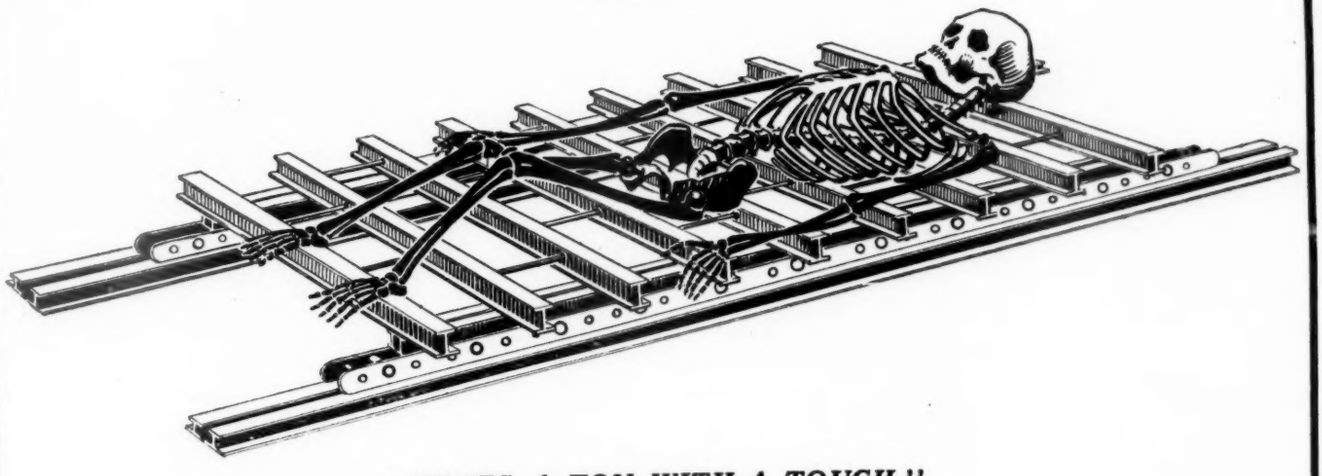

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The Week's News in Brief

Trade Talk

MEN in the civil engineering construction industry are to have their wages raised by a halfpenny an hour.

EMPLOYEES of Babcock & Wilcox, Limited, Dumbarton, have contributed over £283 to local charities during the past six months.

UNITED ENGINEERS, LIMITED, of Singapore, made a net profit in the year ended June 30 last of $545,556. A dividend of 10 per cent. is being paid on the ordinary shares.

HENRY BERRY & COMPANY, LIMITED, hydraulic engineering specialists, have closed their London office at Abbey House, Victoria Street, and ask that all communications be sent to Croydon Works, Hunslet, Leeds.

A 57-FT. 6-IN. BOGIE has been built by Head, Wrightson & Company, Limited, Thornaby-on-Tees, for the English Steel Corporation, Limited. The bogie, which is all-welded, has a carrying capacity of 300 tons of steel ingots.

THE PIG-IRON BOARD has decided on an increase of 6 per cent. for workers operating on the sliding scale, and a minimum increase of 3s. 6d. a week for lower-paid workers employed in the blast-furnace trade in Scotland. These increases will operate immediately.

WORKERS employed in the Willenhall foundry trade (approximately 1,000) have received an increase of 10 per cent. in their wages, following upon a conference held last week between the Willenhall Ironfounders' Association and the National Union of General and Municipal Workers.

SUBJECT to the consent of the Treasury, G. D. Peters & Company, Limited, railway and road rolling stock equipment manufacturers, of Slough, recommend a capital bonus of 50 per cent.—one share for each two held. The distribution—£50,625 of reserve will be capitalised for the purpose—will be to shareholders registered on December 29.

THE MINISTRY OF LABOUR AND NATIONAL SERVICE announces an 'extension of the terms of reference of the University Joint Recruiting Boards and their Technical Committees which interview men under the age of twenty-five with certain prescribed technical or scientific qualifications and make recommendations as to how such men can best be used. The extension of the terms of reference brings within the scope of this arrangement students in certain subjects of a technical or scientific nature at an earlier stage in their course than was previously the case, and also students in certain additional subjects. The classes of men who may now be dealt with include the following:—(1) Men with University degrees in engineering, metallurgy, chemistry, physics, geology, and mathematics (including statistics); (2) men with Higher National Diplomas or Higher National Certificates in mechanical or electrical engineering, or with the Associateship of the Institute of Chemistry; (3) (i) men who have completed to the satisfaction of the University at least one year's work of a course for a specialised honours degree in engineering, metallurgy, chemistry, physics, applied mathematics, and geology, and (ii) men who have started or are about to start their final year's study for a pass degree in engineering or metallurgy; (4) men who have started or are about to start their final year's study for the Higher National Diploma or Higher National Certificate in mechanical or electrical engineering or for the Associateship of the Institute of Chemistry. Men under the age of 25 falling within any of the above classes may apply to a local office of the Ministry of Labour and National Service for forms of application and the address of the nearest Joint Recruiting Board.

Obituary

THE DEATH has occurred of Mr. W. A. Dexter, who for over 37 years took an active part in the management of Mirrlees Watson Company, Limited, engineers and founders, Glasgow.

MR. ROBERT T. RUSSELL, for over 30 years a director of R. Russell & Sons, Limited, ironfounders, of Derby, has died at the age of 83. The firm was founded by his father, Alderman Robert Russell.

Personal

MR. FRANK G. BIRD has changed his address from 6, Manor Road, Tynemouth, to "Woodlands," Jesmond Park West, Newcastle-upon-Tyne.

MR. H. H. SHEPHERD, President of the East Anglian Section of the Institute of British Foundrymen, has changed his personal address from 8, Newry Avenue, Felixstowe, to 595, Felixstowe Road, Ipswich.

MR. JOSEPH WALTON, a director of Thos. W. Ward, Limited, has been appointed an assistant managing director of the company. For many years he has been associated with the rail and siding construction department. Mr. Walton is also managing director of the Darlington Railway Plant & Foundry Company, Limited.

MR. GEORGE SCOTLAND, who has just retired from active managerial duties with Falkirk Iron Company, Limited, was presented with an auto-radiogram before a large gathering in the office by Capt. H. J. Kennard, R.N., chairman of the firm, who was accompanied by Mr. W. H. Smith, managing director. Mr. Scotland joined the company 32 years ago, and although giving up the post of manager will remain a director, continuing also as the firm's representative in Federation matters. Paying tribute to Mr. Scotland, Capt. Kennard said his duties had not been confined to the company only. The structure and sound basis of the National Light Castings Federation stood as a monument to his organising ability. The makers' good understanding with their workers was largely due to his efforts. The Federation had asked him to continue in the capacity of President. The workmen have presented Mr. Scotland with a walnut Westminster chime clock.

Wills

ROBERTS, HARRY, chairman of William Roberts & Sons, Limited, Phœnix Foundry, Nelson £4,322

CLOSE, G. A., of Rochdale, a director of various companies, including the Rochdale Aluminium & Bronze Foundry Company, Limited ... £169,629

Applications for Trade Marks

The following list of applications to register trade marks has been taken from the "Trade Marks Journal":—

"MAGNEPLI"—Refractory bricks for use in furnace linings. REFRACTORY BRICK COMPANY OF ENGLAND, LIMITED, Steetley, Worksop, Notts.

"MELRASAL"—Fluxes for soldering, brazing, melting, and refining metals. MAGNESIUM ELEKTRON, LIMITED, Abbey House, Baker Street, London, N.W.1.

Company Reports

Birmid Industries, Limited—Net profit to October 31, £118,109; brought in, £30,236; dividend of 10 per cent., plus a bonus of 5 per cent.; to reserve, £60,000; carried forward, £21,557.

Crompton Parkinson, Limited—Profit for year to September 30 last, £404,903; brought in, £71,626; to reserve, £125,000; benevolent fund, £5,000; final ordinary dividend of 7½ per cent., making 15 per cent., plus a special cash bonus of 5 per cent.; carried forward, £81,392.

Walmsleys (Bury), Limited—Net profit for year to September 30, after income tax and N.D.C., £62,227; brought in, £93,890; preference dividend, £13,000; ordinary interim dividend of 5½ per cent., £16,500; final dividend of 8½ per cent., £25,500; carried forward, £101,117.

Hepworth & Grandage, Limited—Profit for the year to September 30 last, after charging depreciation and maintenance of plant, £57,529; brought in, £20,706; income tax, N.D.C. and E.P.T., £11,365; dividend of 10 per cent. for the year, £20,500; to general reserve, £20,000; carried forward, £23,984.

War Commodity Insurance

WHEN IRON AND STEEL GOODS ARE INSURABLE

Correspondence between the Distributors of Builders' Supplies Joint Committee and the Board of Trade clears up queries which may be existent in connection with what is excluded from insurance under the War Commodity Insurance Order. As from December 3, 1939, the rate for insurance will be ¼ per cent. per month. Up to the present, the Board of Trade have not taken action against firms who have failed to insure. It may, however, be taken as definite, now that queries have been settled, that steps will be taken at an early date to prosecute firms who have not taken out their insurance.

The iron and steel headings in the insurance Order have been much simplified by definitions given by the Board of Trade. It is made clear that the term "Fabricated," in connection with constructional work, is intended to apply to the preparation for assembly of iron and steel into the finished form, but not to apply to the finished form itself. For example:—(*a*) Sheets or plates, prepared for making buckets or tanks, would be regarded as "fabricated." (*b*) Angles, tees and bars prepared for use in a roof or bridge, would be "fabricated." In either of these illustrations the "fabricated" material would not be insurable. In connection with the description "Wholly or Partly Machined," the word "machined" is understood throughout not to apply to fettling, or the provision of holes. Accordingly, the undermentioned iron and steel headings: "Angles, Channels, Tees, Joists, Piling Sections and Other Sectional Material, whether Fabricated or not"; "Rounds, Rods, Wire Rods, Squares, Hexagons, Flats and all other Sections and Shapes other than Bright"; "Plates, Medium Plates, whether Fabricated or not," now become capable of interpretation by the trade.

"Sheets, Coated and Uncoated," includes all sheets. "Castings, Blocks for Forgings, Blocks for Pressings, Forgings and Stampings (except where wholly or partly machined), and Pressings"—it was understood, so far as this applied to "Castings," that it includes malleable and grey iron castings in the rough, or rust-proofed, of the type generally known in the trade as "Building and Engineering Castings." These would not be insurable. When such castings are surface finished, enamelled or "machined," they would have to be insured, as would all types of "Fitted Goods," such as stoves and ranges, closet cisterns, radiators, ironmongery, pumps and gas fires. Stampings and pressings, as they leave the press and if not "machined," would not be insurable.

"Pipes and Hot-Finished Tubes" would exclude from insurance all types of iron and steel pipes or tubes, and their tubular fittings, with the exception of solid and cold-drawn tube, which would still require to be insured.

"Assemblies of Plates and Sectional Materials as Component Parts of Structures" (which replaces "Structural Work; including Bridge, Pier Tank and Plate-work, whilst at producer's works").—This heading excludes from insurance the parts (as already provided for under "fabricated steel"), loose, partly or experimentally assembled, ready for delivery.

Where the total value for the time being of the insurable stocks (*i.e.*, not including those which have been declared to be uninsurable) is £1,000 or less, insurance is optional.

New Company

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Harrison Andrew (Precision Engineers), Limited, 37, Sheen Lane, Mortlake, London, S.W.14—Capital, £100. Director: W. R. D. Andrew.

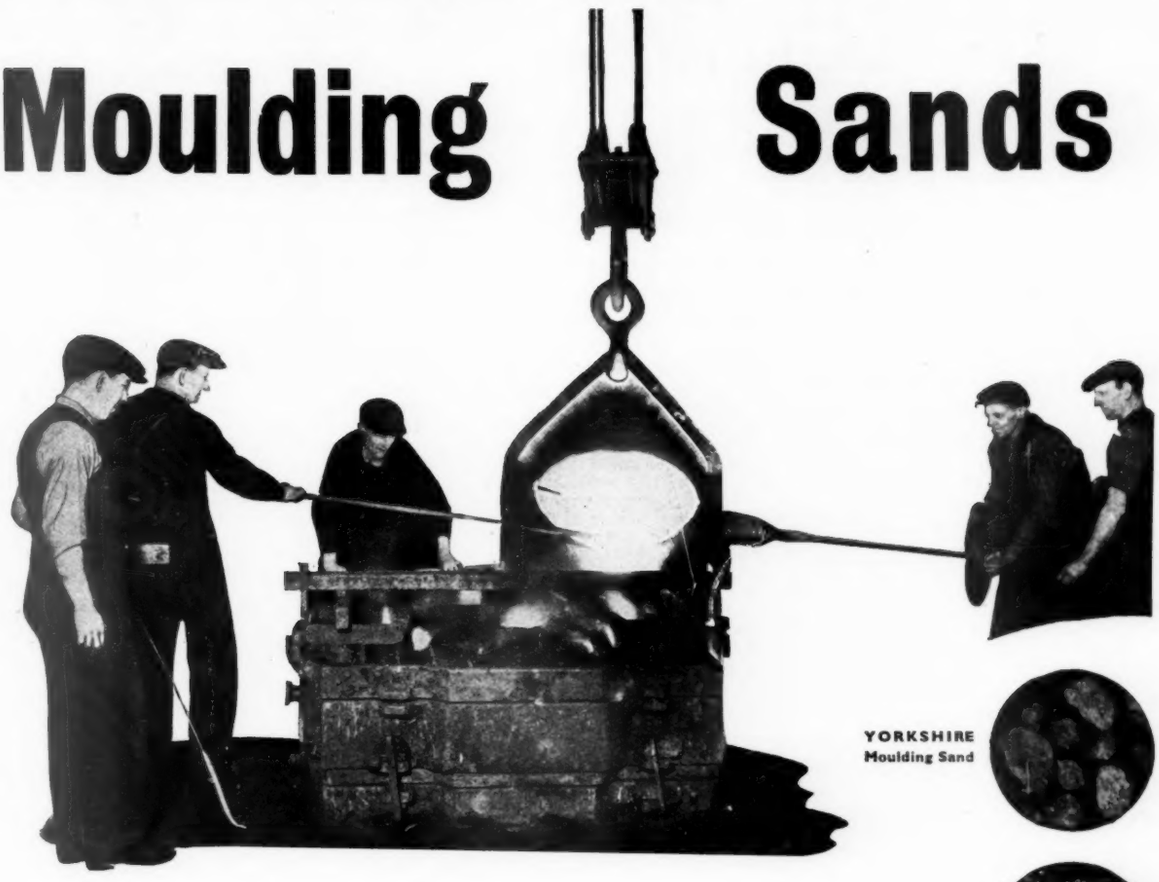
Forthcoming Event

Institute of British Foundrymen

DECEMBER 23.

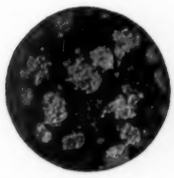
Falkirk Section:—"The Balanced-Blast Cupola and Fluidity in Cast Iron," Paper by W. Y. Buchanan, at Temperance Café, Lint Riggs, Falkirk, at 6 p.m.

Moulding Sands

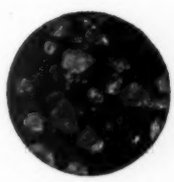


YORKSHIRE
Moulding Sand

THANET
Moulding Sand



YORK YELLOW
Moulding Sand



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Raw Material Markets

As reported in our last issue, the main iron and steel products may now be imported duty free by consumers in this country. An import licensing system is to be introduced, which will give the Government powers to restrict imports both acording to tonnages and sources of supply. While the needs of the consumer at home are being given primary consideration, the Government, and indeed manufacturers themselves, are anxious to expand the export trade in view of the additional importance of this section during the war. British exporters have the opportunity of establishing contact with markets hitherto held by Germany, as, owing to the efforts of the Royal Navy, that country will be increasingly restricted in her dealings with customers overseas.

Pig-Iron

MIDDLESBROUGH—Deliveries of iron to consumers in the Cleveland area are generally satisfactory now that the licensing system is operating to the full extent. Many users who were unable to procure their whole requirements are now at least assured of adequate supplies to meet their early needs, and, in the circumstances, their inability to book far ahead is not causing much inconvenience. Local foundrymen are busily employed on the production of heavy castings, but makers of light castings continue to be in need of new business. Production of Cleveland foundry iron is still suspended. The removal of the import duties on the main iron and steel products is regarded favourably, as consumers will welcome the opportunity to take up supplies of certain products from abroad.

There continues to be a strong demand for hematite, particularly the special descriptions, some of which have become difficult to obtain without delay. East Coast mixed numbers and No. 1 grade are still available in good tonnages. The insistent home demand does not facilitate the transaction of export business, which could easily be done on quite a good scale.

LANCASHIRE—The demand for pig-iron has increased slightly of late, and additional licences have been granted. Many consumers have still stocks of fairly considerable extent, and before these users can acquire further supplies the reserves will have to be used up. The delivery position in the Lancashire area is quite satisfactory, and unless there is a surprising expansion in requirements, consumers need experience no qualms about having their needs met. Certain jobbing and light-castings foundries are still short of work, but, on the whole, there has been a general improvement during the past few weeks. Demand for hematite is maintained.

MIDLANDS—Apart from light-castings makers, who, although better situated, are still far from being pressed for work, ironfoundries in the Midlands are active and have substantial requirements of iron. Fortunately, these are being met with the minimum of delay and the delivery position has undoubtedly improved since the inception of the licensing system, in so far as all consumers are receiving sufficient iron to enable them to cope with their more urgent orders. Government departments are in the market for large supplies of castings and manufacturers are anticipating a continual expansion in the demand for products in connection with national defence projects. Ordinary domestic users are also receiving fairly good deliveries and the available supply of iron is by no means reserved exclusively to firms on Government lists. Both low-phosphorus iron and hematite are in strong demand, and, while supplies are not so free as might be desired, there is little of which to complain in the matter of distribution. Some users are having to accept deliveries of different qualities from those normally used, but the position is improving.

SCOTLAND—Imports of basic pig-iron are welcomed in order to supplement supplies of home-produced material. The demand is strong, and, although urgent needs are being met, increased supplies would be appreciated. Hematite is in firm demand, too, and, on the whole, deliveries are adequate. With local steel plants operating to capacity, the call for supplies of iron shows no sign of abating and will doubtless be maintained for a considerable time to come.

Coke

The strong tone of the foundry-coke market has been maintained. Consumers, being able to secure their requirements over the first half of the New Year, have not been slow to do so and many users have covered themselves. The current price is 50s. 6d. per ton, delivered Birmingham and Black Country stations, but this price is subject to change according to the requirements of the Control authorities.

Steel

The abolition of the import duties on the main steel products has brought forth some caustic comment from Germany, and the English broadcasts from that country have endeavoured to convince British listeners that the move is an admission of the unfavourable condition of the British steel industry. The Reich radio has delighted in pointing out that the German steel output is so much in excess of the aggregate of British and French production. If the Germans are able to convince themselves that the British steel industry is unable to meet its commitments, they will certainly be unable to induce their English audience of this. There is no truth behind such allegations. The licensing system has already resulted in a material improvement in distribution, and with production at record levels, the position will tend to become easier, as compared with the German situation, in which difficulties are mounting. British exports of galvanised sheets are rising, and other departments of the steel trade are hoping to be able to give additional attention to export orders in the near future.

Scrap

Although the national campaign for the collection of iron and steel scrap has so far only been concerned with certain industrial sources, the results are officially stated to be most gratifying. Large tonnages have been offered which would otherwise have served no useful purpose. The search for scrap is daily increasing in intensity, and deliveries to consumers are expanding correspondingly. Merchants are now handling much more material than has been the case for a long time past, and it should be recorded that they are doing this on a very reasonable scale of remuneration.

Metals

Tin is now virtually a free market, both as regards price and output control. On Friday night the International Tin Committee announced its decision to raise the quota for the first quarter of 1940 by 20 per cent. to 120 per cent. of standard tonnages. Later in the week-end the Colonial Office announced that the Governor of the Straits Settlements had cancelled the Order made on September 18 last prescribing a maximum price for tin in that Colony.

Under the Defence Regulations, 1939, the Minister of Supply has issued the Control of Tin (No. 2) Order, 1939, revoking with effect from December 11 the Control of Tin (No. 1) Order of September 17, 1939. The latter Order fixed maximum prices for tin on the basis of £230 per ton for standard tin, and the new Order removes this limitation.

The decision of the I.T.C. to raise the quota naturally upset many calculations: assuming that the quota for the first quarter would be maintained at 100 per cent., the market anticipated that prices in the United Kingdom and the East would be increased either by allowing the metal to find its own level or by raising the maximum quotation fixed by the Control. The additional quota, of course, rather altered the outlook and the Control's statement revoking the Control of Tin (No. 1) Order did not occasion much surprise, and was, in fact, generally welcomed. Tin interests had long been hoping for such a move, and had not been slow to express their opinions to the authorities. It was stressed that by freeing the tin price a substantial increase would be needed to align Empire prices with those ruling in the United States. Of vital importance at the present time is that the decision will bring forth foreign exchange, which is so urgently required in wartime. The cost of the freeing of the market price to the Government and other consumers in the country will be substantial, but this will be offset by the additional supply of foreign exchange.

On Monday, which was the first opportunity for the market to show its reactions, the price of cash tin advanced by £41, from £230 to £271. The turnover was 400 (25 tons near and 375 tons forward), which is the highest figure since the outbreak of the war. The Buffer Pool's practice of supplying 25 tons daily for distribution to consumers in urgent need of metal is now discontinued.

The freeing of the tin quotation and the increased quota have given the greatest satisfaction in tin circles in Malaya. In fact, only at home has there been any marked dissention in regard to the free price of tin.

The copper market continues to be firm and consumers engaged on work of national importance are in the market for very heavy tonnages. On the whole, their requirements are being met satisfactorily, but deliveries are not yet exactly free. Dealers continue to hope that they will be able to trade in a free market during the war, and, while the tin decision has undoubtedly encouraged them, they are not expecting normal trading conditions to return in the very near future.

With the production of munitions increasing substantially, the demand for spelter continues to expand. Supplies are generally satisfactory. Deliveries of lead are, on the whole, meeting consumers' early needs, but there is little metal to spare.

Although aluminium scrap is not now subject to control, other metals are, and the position with regard to deliveries to consumers is far from being reassuring. The situation is causing considerable concern in market circles.

Import Licensing of Iron and Steel

A Board of Trade Order (the Import of Goods (Prohibition) (No. 10) Order, 1939) will come into force on Monday, December 18, adding to the list of the goods which require a licence for import, iron and manganese ores and the principal forms of iron and steel, and certain materials used in the manufacture of iron and steel.

The intention of the Order is to facilitate the purchase and transport of all necessary supplies of these materials, and so far as is practicable importations will pass through the normal trade channels.

Any goods covered by the Order which have been dispatched to the United Kingdom before the Order comes into force will not require a licence.

Forms of application for licence may be had from the Import Licensing Department, 25, Southampton Buildings, Chancery Lane, London, W.C.2, or from the Iron and Steel Control, Steel House, Tothill Street, Westminster, S.W.1.

For licensing purposes, the materials set out in the Schedule attached to the Order fall into two broad classes—(*a*) iron and manganese ores, concentrates and residues; (*b*) ferro-alloys, pig-iron, and semi-finished and finished iron and steel. Licences for the former will be issued by the Director of Foreign Ores, and for the latter by the Iron and Steel Control.

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